EDISON

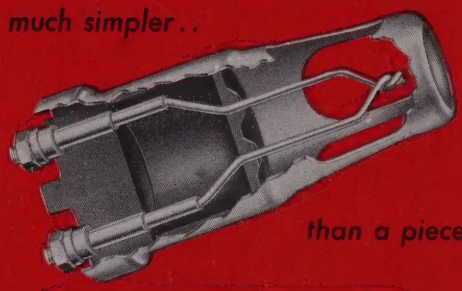
INSTRUMENT DIVISION
THOMAS A. EDISON, INCORPORATED
WEST ORANGE, NEW JERSEY, U.S.A.

EDISON Aeronautical Equipment

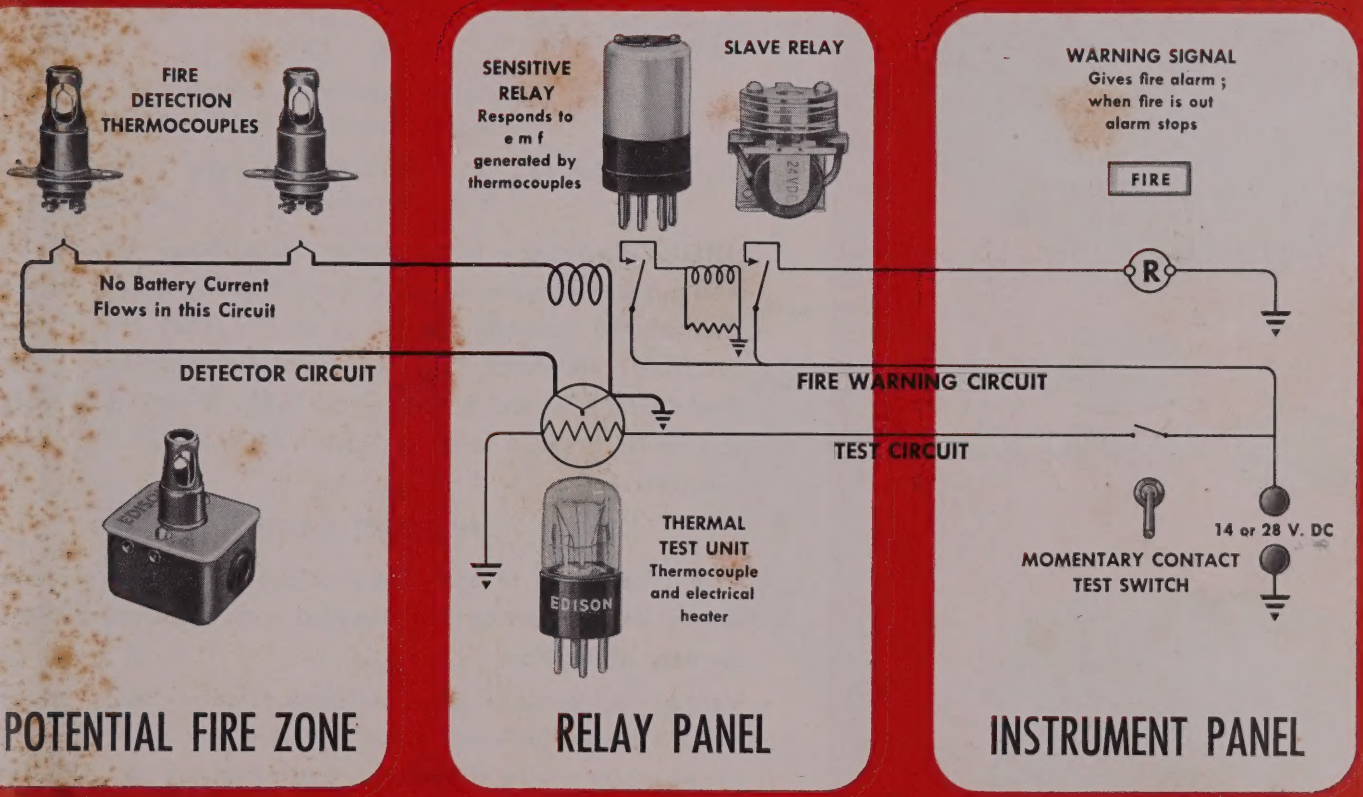
AIRCRAFT FIRE DETECTION SYSTEM

T/Sgt. T. L. Sims

"Nothing's much simpler..



than a piece of wire"



T'S FAST—Virtually instantaneous response is nsured by the extremely low mass of the thermo- ouple "hot" junction. Response time is unaffected y low or high ambient temperature.

T'S DEPENDABLE—Detector thermocouples re- ond only to an abnormally rapid **rise** in tempera- ure. System cannot false alarm as a result of high perating temperature or circuit failure.

The alarm ceases when the fire is out and reappears in case of reignition.

The system may be tested at any time, proving **detectors** as well as all circuits are in operating condition. No change is made in circuit connections during the test.

IT'S SAFE—No battery current enters the fire zone. There are no moving contacts in the detector circuit.

INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

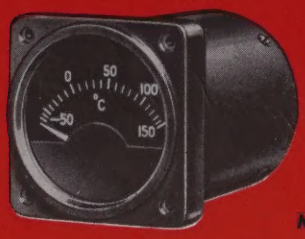
WEST ORANGE, NEW JERSEY, U. S. A.

cation No. 3019

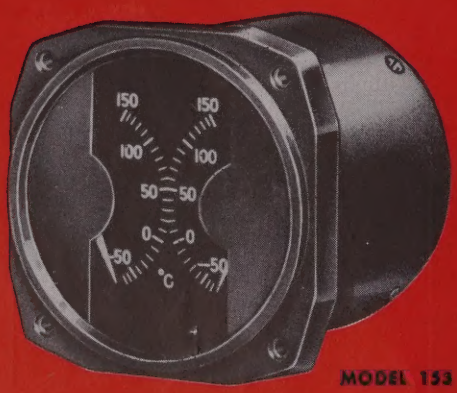
January 15, 1949

EDISON

INDICATORS

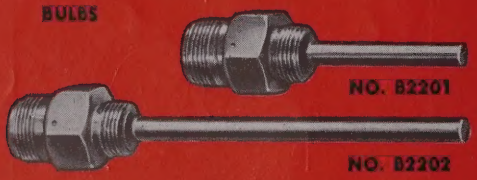


MODEL 152



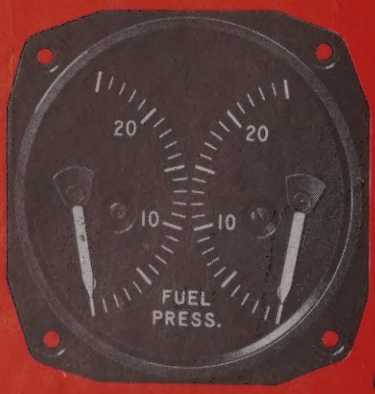
MODEL 153

BULBS



NO. B2201

NO. B2202



MODEL 157

MODEL 158

Printed in U.S.A.

ELECTRICAL THERMOMETERS

For the best in Electrical Thermometers, specify EDISO Ratio Resistance Thermometers and EDISON Resistance Bul

- No indicator is more dependable, simpler to overhaul, or eas to calibrate. There are no delicate moving coils or hairsprin and calibration is accomplished by a rheostat adjustment. Th operate on either a 14 or 28 volt dc power supply. Available both 1 7/8" single and 2 3/4" dual types which are interchang able with AN5790-6 and AN5795-6 indicators respective Both types are made in the following ranges

50 to 150°C	—45 to 45°C	40 to 240°F
20 to 120°C	—50 to 200°C	—20 to 120°F
0 to 120°C	—50 to 50°C	—50 to 120°F
—20 to 70°C	—70 to 150°C	—85 to 150°F
	—70 to 70°C	

Model 152 Single Indicator—Weight ½ lb.
4-pin connector (AN.....14S-2)

Model 153 Dual Indicator—Weight 1 lb.
5-pin connector (AN.....14S-5)

EDISON Resistance Bulbs exceed Army-Navy specificati requirements in speed of response and ability to operate co tinuously at temperatures up to 600°F. They are standa AN5525-1 and AN5525-2 types with ¼" diameter stainl steel stems 1 7/8" and 4" long respectively. Mounted by mea of a 5/8-18 thread. Connector—2-pin (AN.....12S-3). Weig —approx. 2 oz.

PRESSURE GAGES

Dual type gages to conserve precious panel space. Stur simple linkage mechanism provided with adjustment scre for easy calibration.

- Vented fuel pressure gage indicates effective fuel pressu i.e., difference between actual fuel pressure and that of in carburetor mixing chamber. Actuating unit is capsule with vent pressure housing. No mechanical differential mechani to cause trouble. No possibility of spilled fuel due to ruptu capsule.

Model 157 Dual Fuel Pressure Gage—0-25 p. s. i.
Weight 0.7 lbs.

- Oil pressure gage is actuated by short heavy beryllium-cop bourdon tube. Either right-hand or left-hand mechanism m be replaced as a unit.

Model 158 Dual Oil Pressure Gage—0-200 p. s. i.
Weight 0.8 lbs.

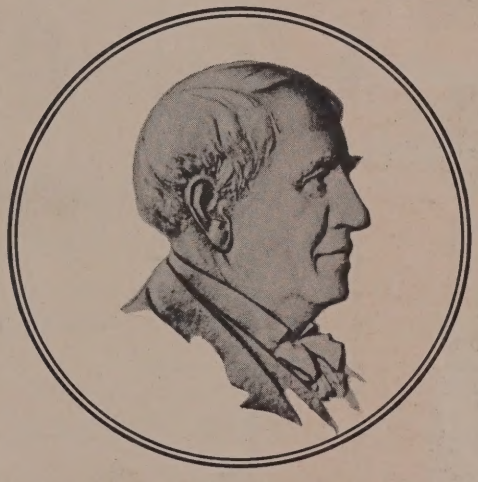
Thomas A Edison

EDISON

GENERAL DESCRIPTION

AIRCRAFT
FIRE DETECTION SYSTEM

TYPE A



Thomas A Edison

INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

WEST ORANGE, NEW JERSEY, U. S. A.

UBLICATION No. 1021A

Printed in U.S.A.

APRIL 15, 1949

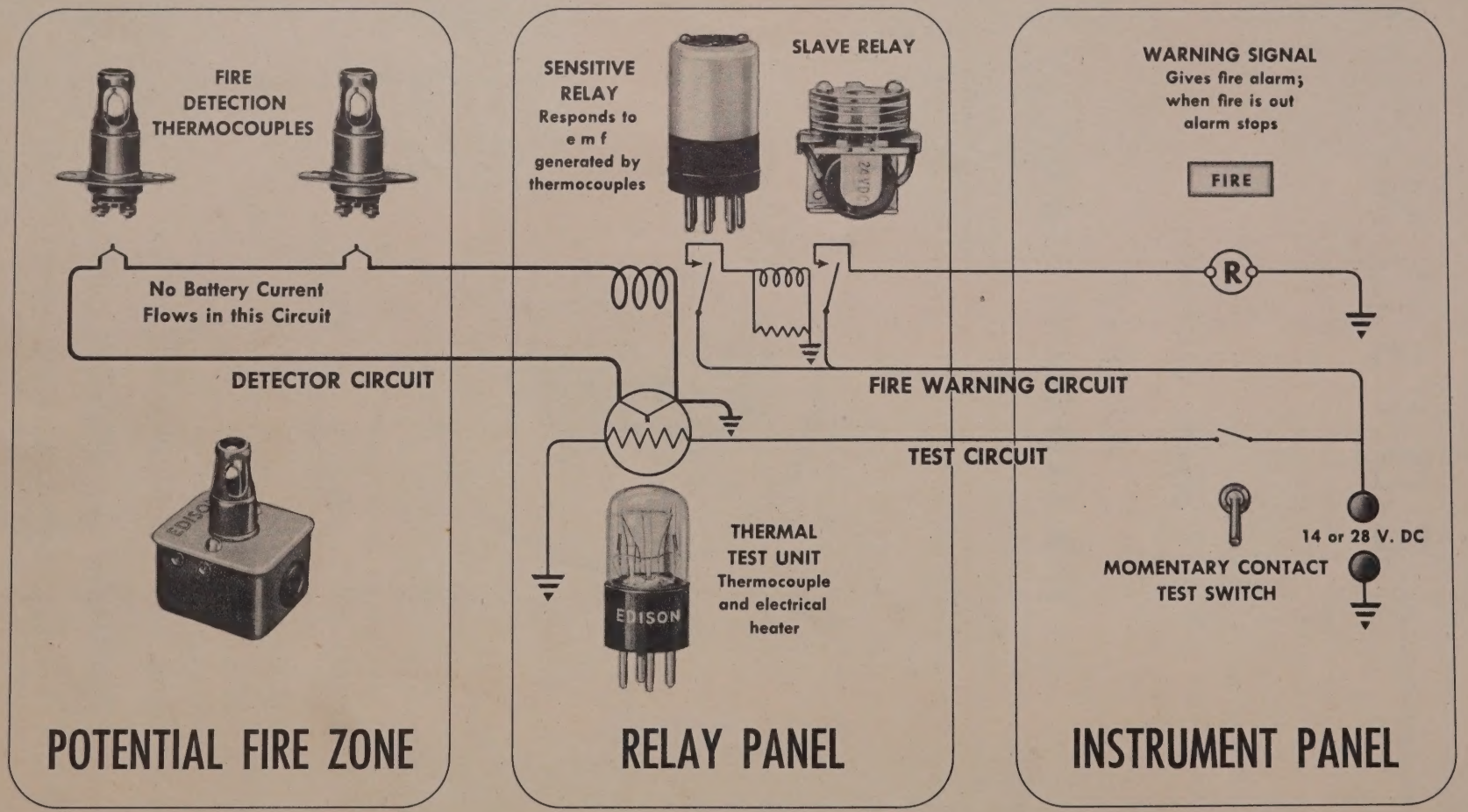


Figure 1 - Basic Circuit of the System

I INTRODUCTION

The Edison Type A Aircraft Fire Detection System was originally developed to detect the presence of fire in aircraft power plants. It is equally well adapted to installation in other potential fire zones such as combustion heaters and hydraulic and electrical equipment compartments.

The system is a rate-sensitive device having a minimum time-constant. In actual service in both military and commercial operation this method of fire detection is repeatedly proving itself to be the most reliable way of sensing fire with the minimum possibility of false alarms. In a properly engineered installation no safe operating temperature can cause an alarm since the electrical characteristics of the detectors are not affected by ambient temperature nor by gradual rises due to engine warm-up or power runs.

Having established the functional objective for the system, Edison engineers designed into the device what they felt were requisites necessary to safety beyond the usual requirements for aircraft equipment.

1. The detectors are designed to operate properly in flame for two successive one minute periods and still produce an alarm when again subjected to fire.

2. The detectors are unaffected by extreme vibration, chemical action of aromatic fuels, oil, or exposure to extreme climatic conditions.

3. No special tools are required for overhaul or maintenance of the system.

4. The integrity of the entire system, including the detectors, may be tested at any time by operating a simple test switch.

5. When the fire is out the alarm ceases and the system is immediately ready to give an alarm in case of reignition.

6. No current from the aircraft power supply ever flows through the detector circuit to become an additional hazard in the potential fire zones.

II CIRCUITS

(Refer to figure 1.)

Three simple circuits make up the system. The detector circuit is permanently closed. It consists of the detector thermocouples and a test thermocouple connected in series with the coils of the sensitive relay. The contacts of this relay, a slave relay, and such warning signal and other devices as may be required for the given installation, constitute the fire warning circuit which is energized by the aircraft power supply. The test circuit is made up of a momentary contact switch which sends current from the aircraft power supply to a heating coils adjacent to the test thermocouple.

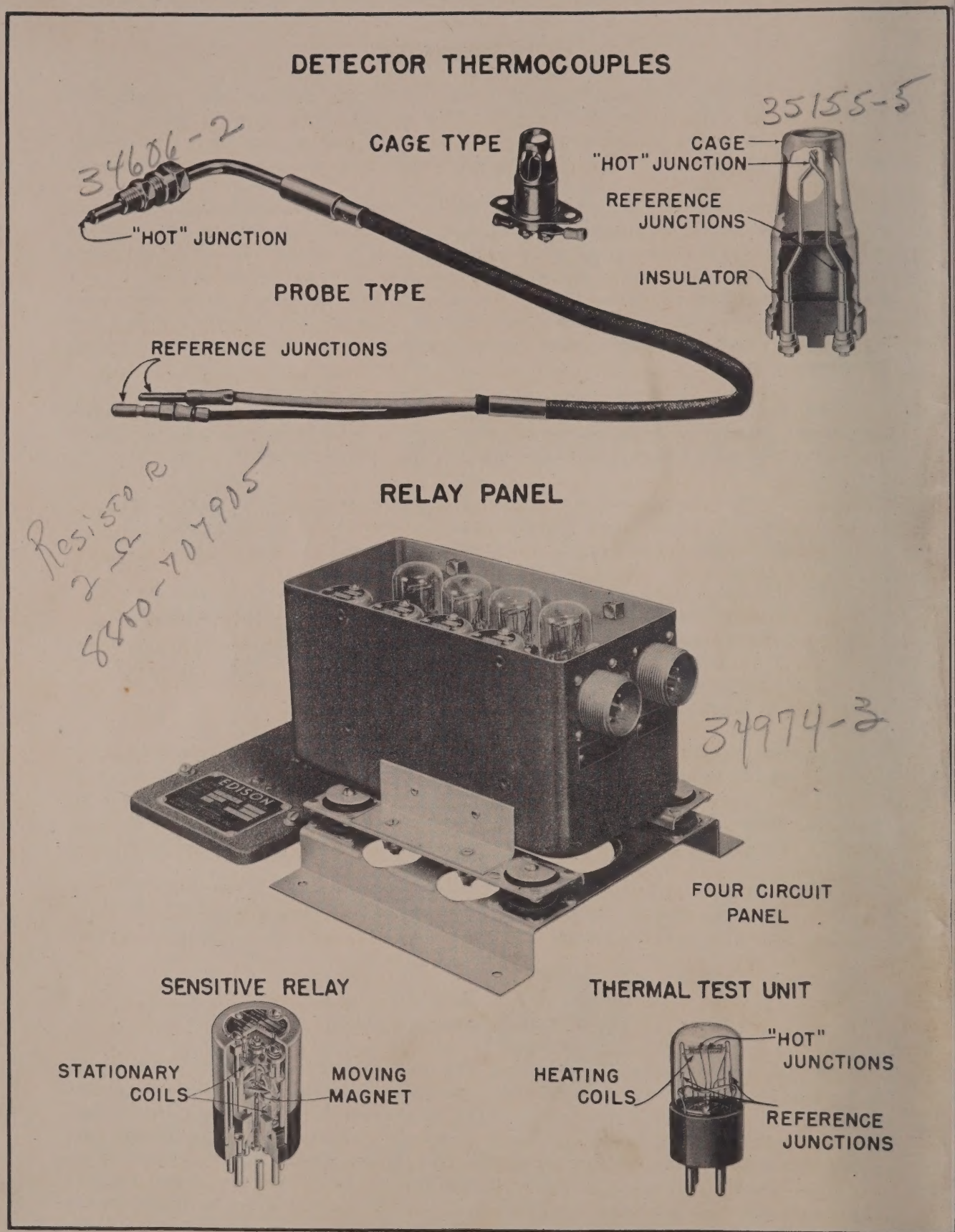


Figure 2 - Major Parts of the System

III COMPONENTS

(Refer to Figure 2.)

DETECTOR THERMOCOUPLES.--The fire sensing unit of the system consists essentially of two wires of dissimilar metals with their outer ends twisted and welded together. They are furnished in two designs, each for a specific application.

Cage-type detectors are used at points of air agress and other strategic locations in potential fire zones such as power and accessory sections of engine installations, combustion heaters, auxilliary power units, and hydraulic and electrical equipment compartments. The thermocouple wires are mounted in a heat-resistant insulator and surrounded by a stainless steel cage. The cage is provided with openings to permit heat to reach the exposed "hot" junction with minimum interference while furnishing maximum mechanical protection. The reference junctions or points where the thermocouple wires are attached to terminal screws, lie within the insulator.

For installation in aircraft engine fuel induction systems, probe-type detectors are used. The "hot" junction is at the end of a supporting stem which extends through a pressure-tight fitting into the potential fire zone. The connection between the leads and the circuit furnish reference junctions outside the fire zone.

RELAY PANEL.--A relay panel, which may be mounted in any accessible location, furnishes a suitable housing for the sensitive relay, slave relay, and thermal test unit. These panels are normally supplied in models to serve two, four, or six detector circuits. One, three, and eight circuit panels have been furnished when required.

The sensitive relay is an entirely enclosed unit provided with a seven-pin base for plug-in mounting in the panel. The moving element is a small permanent magnet which is pivoted between two stationary field coils. Elimination of the usual large fixed magnet substantially reduces weight, while lack of delicate moving coils and multiple current-carrying hairsprings greatly simplifies service operation.

Since the load-carrying ability of the sensitive relay is necessarily limited, a slave relay is employed which permits the operation of master warning devices.

The thermal test unit consists of a thermocouple with a pair of heating coils adjacent to its "hot" junction. In order to secure uniformity of operation and to avoid possible fire hazard, these parts are sealed within a glass bulb. A four-pin base provides for plug-in mounting in the relay panel.

WARNING DEVICES AND TEST SWITCHES.-- These devices, which are not supplied by the manufacturer of the fire detection system, vary with the installation involved. Warning lights for each detector circuit as well as a master visual or audible warning signal actuated by all circuits is usual. However, where so desired two or more circuits may be caused to operate a single warning device.

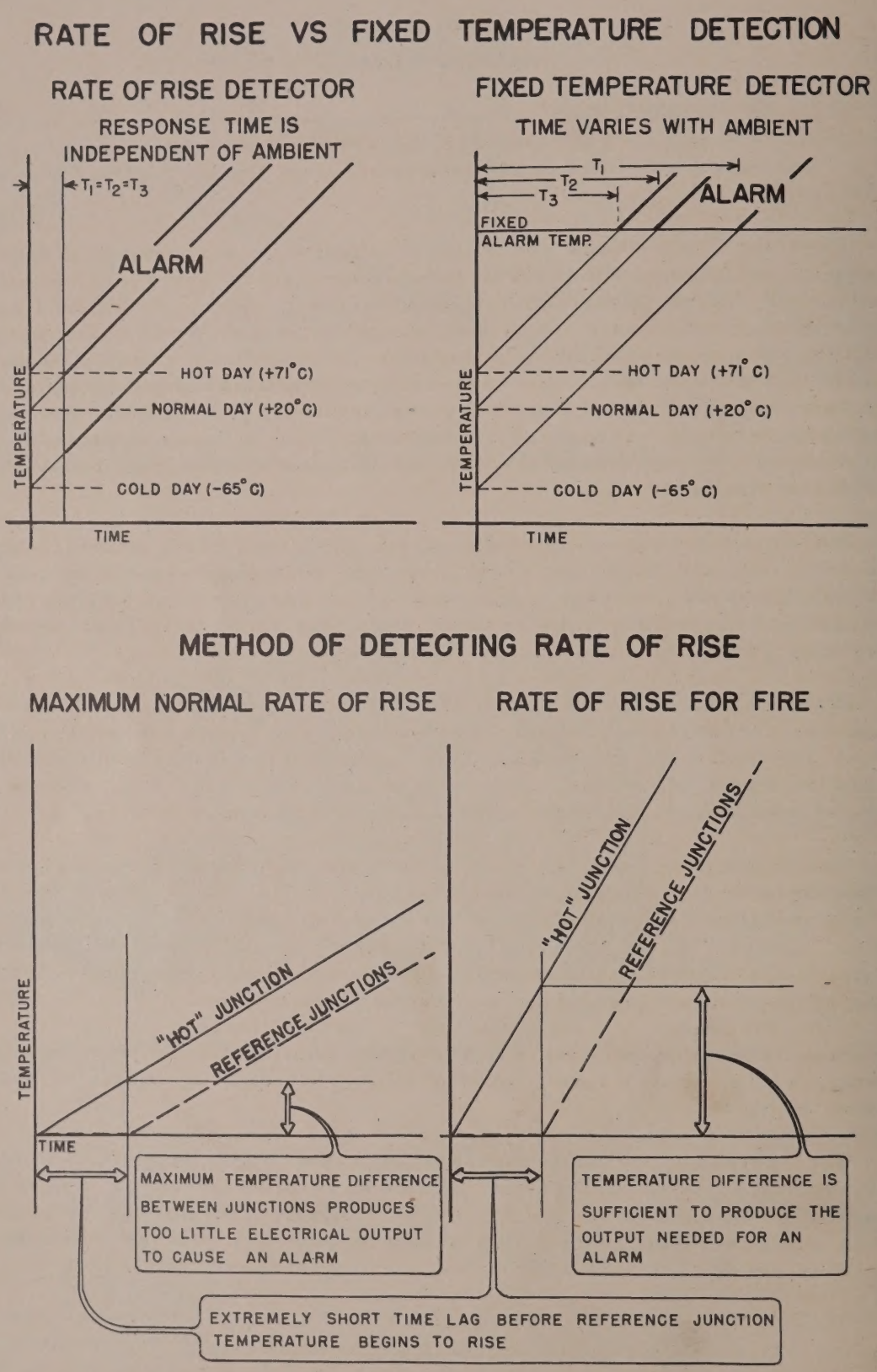


Figure 3 - Principle of Operation

IV PRINCIPLE OF OPERATION

(Refer to figure 3.)

This fire detection system is unique in that thermocouples are used as the fire sensing units. An alarm occurs only when temperature rises at an abnormal rate, and not because it has reached any fixed value. A thermocouple may be considered a simple power generator whose output results from a difference in temperature between its "hot" and reference junctions. The operation of the Edison fire detector thermocouple, however, must not be confused with that of the more conventional thermocouple used to actuate certain types of temperature indicators. In the latter, the object is to compare a variable temperature with a fixed standard. For that reason only the hot junction is exposed to the critical temperature, the reference junctions being completely isolated from its zone of influence.

The fire detection thermocouple, on the other hand, is designed to produce an e.m.f. proportional to rate of rise of ambient temperature. Both junctions are located in the zone of influence of the variable temperature, with the reference junctions so insulated that their response to a change in ambient temperature will lag behind the response of the "hot" junction by a fixed time interval. The more rapid the change in ambient temperature, therefore, the greater will be the temperature difference between the "hot" and reference junction and the higher the output of the detector.

The fire detection system as installed in an airplane is so set up that the total output of all of the series-connected thermocouples of a detector circuit is insufficient to operate the sensitive relay under normal operating conditions. But in case of fire the output of any one detector will cause an alarm.

Since only current generated by the thermocouples ever flows through the detector circuit, grounded or broken wires can neither prove a fire hazard nor give a false alarm. A thermoelectric current is generated by operating the test switch which heats the thermocouple in the thermal test unit. If there is continuity through all parts of the detector circuit, including the detector thermocouples, the output of the thermal test unit will close the sensitive relay and result in an alarm, thus completely checking the integrity of the system.

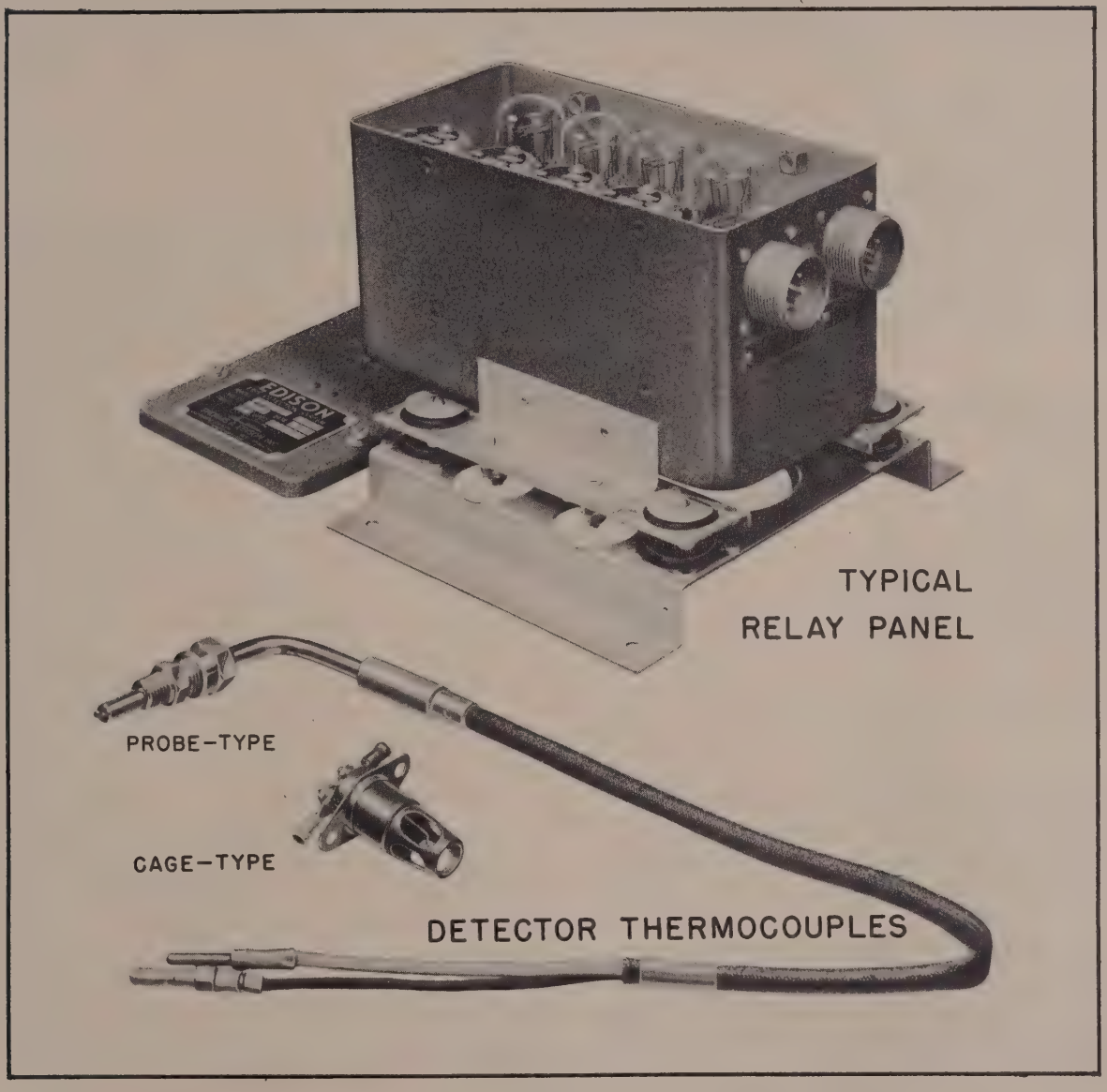
In order that the system be properly adapted to the operating conditions and fire zone configurations of the particular model of aircraft involved, Edison engineers are ready to assist in the development of prototype installations.

LINE MAINTENANCE MANUAL

FOR

AIRCRAFT FIRE DETECTION SYSTEM

TYPE A



INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

WEST ORANGE, NEW JERSEY, U. S. A.

I INTRODUCTION

This Line Maintenance Manual is applicable to all Type A Aircraft Fire Detection Systems manufactured by the Instrument Division, Thomas A. Edison, Incorporated, West Orange, New Jersey, U.S.A. Information contained herein supersedes that given in all former editions of this publication.

Data covering installation in a particular make and model of airplane must be secured from the aircraft manufacturer or airline engineering department. For description and discussion of operating principles refer to Publication No. 1021; and for overhaul instructions see Publication No. 1023.

II INSTALLATION

1. NEW INSTALLATIONS.

Specifications contained in aircraft manufacturer's or airline engineering department's blueprints, based on recommendations in Edison Publication No. 28, should be followed in installing the system.

2. REPLACEMENTS.

a. GENERAL. - Before removing a defective part, note its position and method of mounting, then install replacement unit in same manner.

b. DETECTOR THERMOCOUPLES

(1) Cage-type thermocouples are connected in series. Note which wire was connected to the identified (+) terminal of the defective unit, and connect the replacement in the same manner.

CAUTION

Output from reversed thermocouples will not only fail to operate the system, but will tend to counteract the output of the other thermocouples.

(2) POLARITY TEST.-Following installation of thermocouples or overhaul of assembly containing all or part of a detector circuit, check circuit for thermocouple polarity. Use Model 140-5 or 140-9 Fire Detector Test Set or connect a milliammeter across the connector plug sockets of the detector circuit involved, observing polarity of meter terminals and sockets. (See figure 1,) Successively heat the thermocouples by means of a detector thermocouple test heater. (See section III, paragraph 2.a.(4).) Meter deflection should be clockwise with rising temperature.

NOTE

It is recommended that Model 108-5 detector thermocouples be replaced with the improved Model 108-8. Model 108-5 is equipped with two studs with #6-32 threads, while the negative and positive studs on Model 108-8 have #8-32 and #6-32 threads respectively. This change will considerably lessen the possibility of accidental reversal of polarity at the thermocouple during servicing of the fire detection system. To facilitate changeover to the new model, terminal lugs are furnished with these detectors. It will be necessary to replace the #6 lugs formerly used on the negative stud with the #8 lug supplied.

c. RELAY PANELS.

(1) DISCONTINUED PANEL MODELS.-Certain relay panel models are no longer manufactured, although parts for overhaul purposes are still available. When such a panel must be replaced, use the corresponding current model listed below. Dimensions and mounting arrangements, camloc locations, and electrical receptacles of the two are identical.

OBSOLETE	CURRENT
2-CIRCUIT PANELS	
117-7	117-26
117-11	117-31
117-14	117-27
117-21	117-28
3-CIRCUIT PANELS	
117-24	117-29
4-CIRCUIT PANELS	
117-4	117-44
117-5	117-55
117-6	117-66
117-9	117-99
117-12	117-32

(2) CAMLOC FASTENER INTERCHANGEABILITY.-Early panels were equipped with short male camloc fasteners. If such a panel is to be installed on a shock-mount with modern receptacles, replace the male fasteners with #NA13158-2 fasteners (Camloc #2500-E5). Current type panels fit old style shock-mounts without modification.

(3) TERMAL TESTS UNITS AND SENSITIVE RELAYS.-With the cover removed from the relay panel, the test unit or relay may be pulled out of its radio tube type socket. Replace defective part with a new one.

CAUTION

When replacing thermal test units be sure contact pins on base are not forced into incorrect socket holes. Failure to observe this caution would render the system inoperative and possibly burn out the thermocouple in the test unit.

d. WIRING.

(1) In potential fire zones, use only 400°F High Temperature Aircraft Wire, #18 or larger.

(a) Terminate wiring at cage-type detector thermocouple locations in "Pre-insulated Diamond Grip Terminals" (Aircraft Marine Products, Inc.). Use #NA13370, (A.M.P. #34579), #6 lug for positive (+) terminal of Model 108-8 detector thermocouple, and for both terminals of Model 108-5. Use #NA13371, (A.M.P. #34580), for negative terminal of Model 108-18.

(b) Terminate wiring for connection to probe-type thermocouple in 2-pole terminal block suitable for AN5539-1 lug type terminals or in AN5537 thermocouple lead connector assemblies as required by thermocouple involved. (See figure 1.)

(2) Use standard insulated low voltage aircraft wire of adequate size (#18 is suggested, for all other connections.

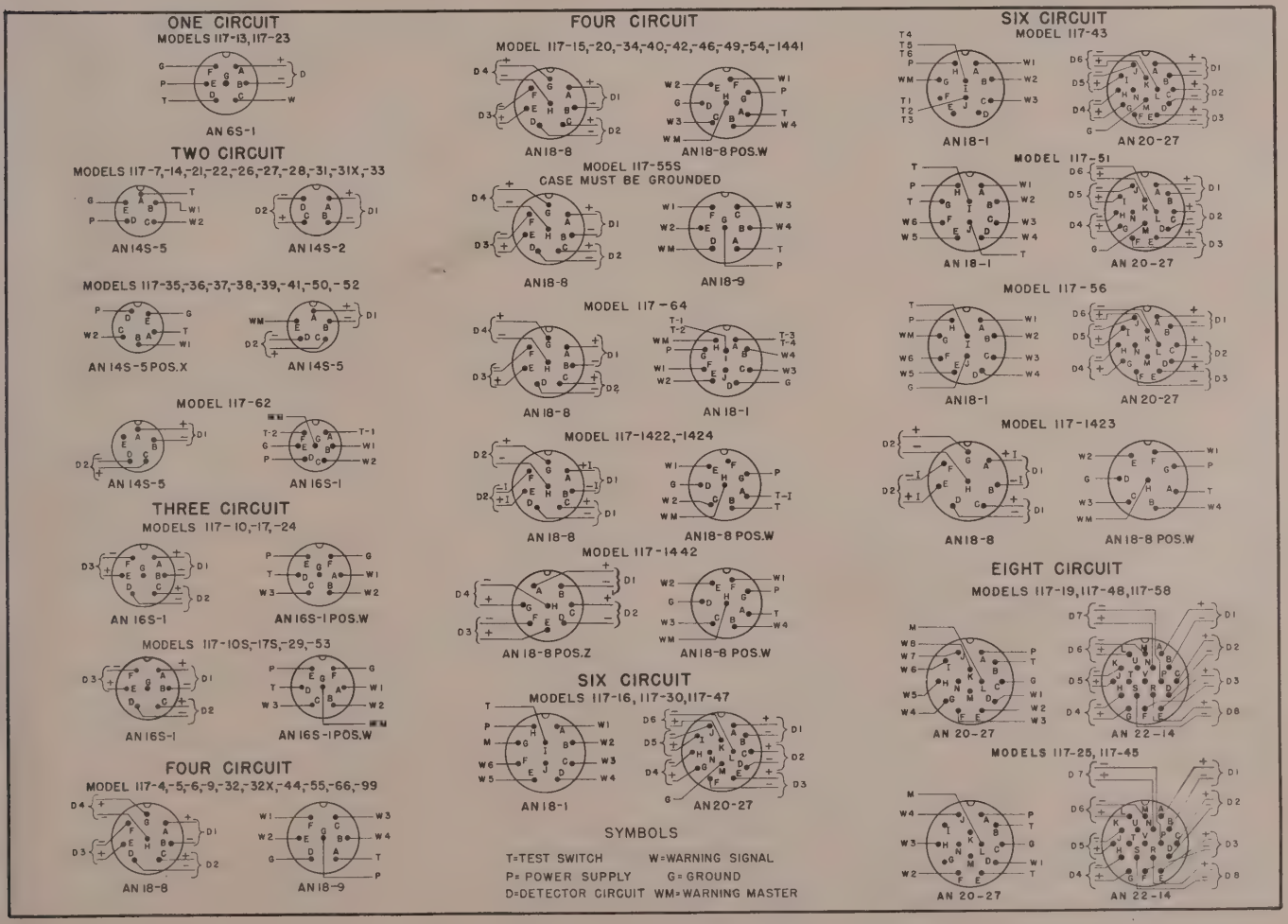


Figure 1 - Relay Panel Receptacle Terminal Layouts

III SERVICE INSPECTION AND MAINTENANCE

1. RECOMMENDED SERVICE INSPECTIONS.

a. PREFLIGHT INSPECTION.-During preflight ground run-up, operate test switch to obtain a test alarm. Failure of any circuit to alarm within 15 seconds indicates existence of a defect which might or might not prevent a fire signal.

b. PERIODIC INSPECTION.

(1) Inspect detector thermocouples to be sure that they are securely mounted.

(2) Check connections for tightness and clean contact.

(3) Check to be sure no foreign matter which might ground the exposed junction to the shell has lodged in the thermocouples.

(4) Inspect wiring to be sure it is firmly secured and undamaged.

(5) Inspect relay panel for deterioration of shock-mounts or other evidence of defects.

c. ENGINE CHANGE INSPECTION.

(1) Perform all operations described under Periodic Inspection.

(2) After detector circuit is reconnected to ship's circuit, test all detector thermocouples for polarity. (See section II, paragraph 2.b.(2).)

d. AIRFRAME OVERHAUL INSPECTION.

(1) Perform all operations described under Periodic Inspection.

(2) Test all detector thermocouples for polarity. (See Section II, paragraph 2.b.(2).)

2. MAINTENANCE.

a. TEST EQUIPMENT.

(1) DETECTOR CIRCUIT TEST PLUG OR CABLE.-Obtain a connector plug to fit the detector receptacle of the relay panel involved. Short-circuit each pair of detector circuit pins ("D" in figure 1), avoiding interconnecting the various circuits. If this receptacle serves other circuits in addition, make up a plug and receptacle cable with detector pins shorted as above.

(2) ALARM CIRCUIT TEST PLUG.-Obtain a receptacle to fit the alarm circuit connector plug when same is disconnected from the relay panel. Connect all warning signal terminals ("W" in figure 1) to the test switch terminals ("T").

(3) EXTENSION CABLES.-In some installations it will be found convenient to use extension cables to permit the relay panel to be removed from its regular position to a more accessible location during tests. These cables consist of pin-type and socket-type connector plugs of the necessary kind, connected by flexible wire.

(4) DETECTOR THERMOCOUPLE TEST HEATER. To facilitate testing of cage-type thermocouples, it is recommended that a large electric soldering iron be fitted with the special copper tip shown in figure 2. After having been heated, the self-positioning tip is placed over the detector thermocouple. The resulting rate of temperature rise is sufficient to produce a measureable current.

(5) DETECTOR CIRCUIT ENERGIZER.-To facilitate testing detector circuits for open conections, it is recommended that a circuit energizer consisting of one size D dry cell and a 100 ohm, 2 watt resistor be constructed. Provide the negative side of the cell with a battery clip and connect the resistor in series with the positive terminal and a four-foot lead fitted with a test prod.

(6) EDISON TEST SETS.-Model 140-5 and 140-9 Fire Detector Test Sets are recommended for routine testing of the detector circuit. Operating Instructions (Publication Nos. 18 and 1038 respectively) are furnished with the equipment.

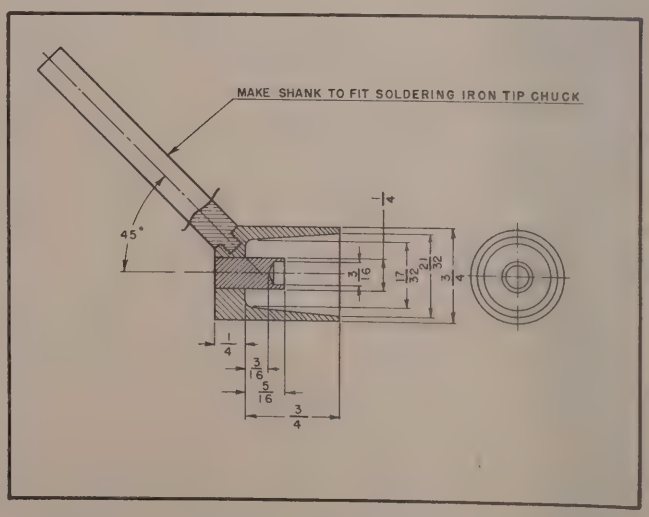


Figure 2 - Detector Thermocouple Test Heater

b. TEST PROCEDURE.

(1) GENERAL PERFORMANCE TEST.-Turn the test switch "ON" until alarm occurs. Any circuit that does not alarm within 15 seconds is defective.

(2) DETECTOR CIRCUITS TESTS.-If above test proves system to be defective, disconnect detector circuit cable from relay panel. In its place, insert the Detector Circuit Test Plug or if Test Cable is required because receptacle serves other circuits, insert same between regular cable plug and panel receptacle. Operate the test switch. If an alarm now results, the detector circuit is the defective portion of the system.

(a) GROUND TEST-Test the detector circuits for grounds by using a Fire Detector Test Set, or an ohmmeter connected between any thermocouple's terminal and the airframe. To locate a ground connect the positive lead of the detector circuit in question to the positive (left hand) test binding post of the Model 140-9 Edison Test Set, or an equivalent meter, and ground the other meter binding post to the aircraft frame. Heat each of the detector thermocouples in turn noting the meter deflection. When two detectors are located that adjoin each other in the circuit, but only one of which causes the meter to deflect when heated, it will indicate that the ground exists between these two detectors.

(b) OPEN CIRCUIT TEST.-Test the detector circuit for continuity by using a Fire Detector Test Set or an ohmmeter connected across the connector plug sockets serving the detector circuit in question. (See figure 1.) Open circuits are easily located by means of the detector circuit energizer. Connect the negative terminal clip of the energizer to the aircraft frame and touch the test prod to the "hot junction" of each thermocouple in turn. When two adjoining detectors are located, only one of which causes a fire signal, the open circuit is between the two.

(3) ALARM CIRCUIT TESTS.-Remove the alarm circuit plug from the relay panel receptacle and plug it into the Alarm Circuit Test Plug. Operate the test switch. Lack of response by any individual warning signal indicates trouble in that particular circuit while lack of all response shows a defective test circuit.

(4) THERMAL TEST UNIT AND SENSITIVE RELAY TESTS.-With both detector and alarm circuits connected to the relay panel, successively test the thermal test unit and the sensitive relay by replacing them with spares and operating the test switch. If the system still fails to operate, the trouble is a defective relay panel.

c. REPAIRS.-It is not recommended that Line Maintenance personnel attempt any repairs other than those listed in the Trouble Chart below. Defective assemblies must be sent to a properly equipped repair shop for further tests and repairs.

TROUBLE	PROBABLE CAUSE	REMEDY
NO ALARM WHEN TEST SWITCH IS ON	Power supply "OFF".	Connect battery or turn switch "ON".
	Defective detector circuit.	
	Grounded wire or terminal.	Insulate grounded conductor.
	Loose or broken wire.	Tighten or replace wire.
	Broken or damaged thermocouple.	Replace thermocouple.
	Defective warning signal circuit.	
	Loose or broken wire.	Tighten or replace wire.
	Defective warning device.	Repair or replace device.
	Defective test switch circuit.	Repair or replace defective part.
	Defective thermal test unit.	Replace test unit.
	Defective sensitive relay.	Replace sensitive relay.
	Defective relay panel.	Replace panel.

NOTE: This system is designed and installed to "fail safe"; i.e., it is inherently free of false alarms. Should false alarms be reported, make a careful examination of potential sources of sudden temperature rise, such as leaky collector rings, etc. Edison Service Engineers are always available to assist in such investigations.

Publication No. 1025
January 15, 1947

OVERHAUL MANUAL

FOR

SENSITIVE MAGNETIC RELAY

MODEL 103 SERIES

INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

WEST ORANGE, NEW JERSEY, U. S. A.

I INTRODUCTION

This Overhaul Manual is generally applicable to all Model 103 Sensitive Magnetic Relays manufactured by the Instrument Division, Thomas A. Edison, Incorporated, West Orange, New Jersey, U. S. A. Specifically the procedures described apply to the Model 103-2 relay used in the Edison Type A Aircraft Fire Detection System. When other models are to be overhauled, due consideration must be given to slight differences in operation, construction and adjustment. For complete parts listing, refer to Publication No. 1024.

The Edison Sensitive Magnetic Relay somewhat resembles a small metal radio tube in size and appearance. (See cover illustration.) The movement is enclosed within a cylindrical aluminum cover and is mounted upon a plastic base provided with contact pins to fit a standard small seven-pin radio tube socket.

The moving part of the relay mechanism, the rotor, has a small alnico magnet vane at its lower end and a hairspring, balance cross with weights, and a contact arm at its upper end. The rotor shaft is supported in jeweled bearings with the vane positioned between two stationary coils. When the coils are energized, the reaction between their magnetic fields and that of the vane causes the rotor to turn, thus either opening or closing the connection between the contact arm and a stationary contact wire or wires which are attached to the bridge assembly. A hairspring serves to carry the secondary current to the contact arm, and also to return the rotor to its original position when the current ceases to flow through the coils. The magnetic system of the relay is enclosed in a highly permeable shield which prevents external magnetic fields from affecting the relay.

The four terminals of the stationary coils are connected to separate pins to allow series or parallel connections, or for differential operation, to permit the coils to be separately energized.

II TEST PROCEDURE

1. TEST EQUIPMENT.

To facilitate testing and adjusting of sensitive relays, it is recommended that a test stand similar to the one shown in figure 1 or that described in Publication No. 1023, be built and made part of the permanent shop equipment. For the construction of this apparatus, which is specifically designed for use with Model 103-2 relays, in addition to materials ordinarily stocked, the following parts are required:

1 Switch—S. P. S. T.

1 Potentiometer—2 watt, 500 ohm, complete with knob.

1 Socket—7 pin (Edison #33877 or equivalent).

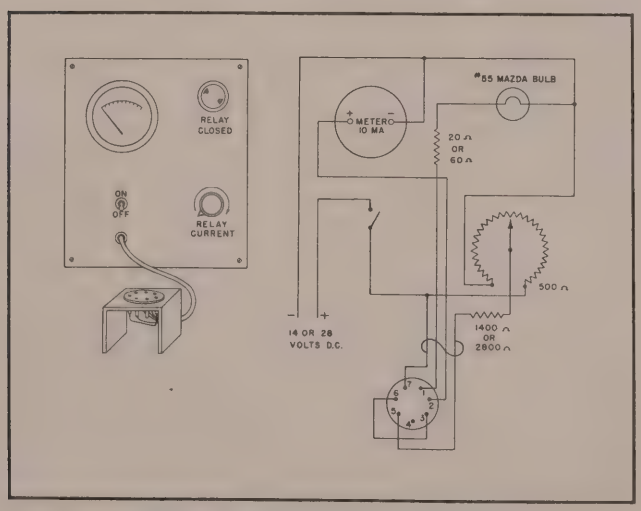


Figure 1—Suggested Test Stand for Model 103-2 Relays

1 Resistor—10 watt, 60 ohm for use with 24-28 volt power supply, or 10 watt, 20 ohm for 12-14 volt supply.

1 Light—bulbs-eye, with #55 mazda bulb.

1 Resistor—1/2 watt, 2800 ohm for 24-28 volt power supply, 1400 ohms for 12-14 volts.

1 Meter—10 milliampere (resistance not to exceed 10 ohms).

The 7-pin socket is mounted on a square base and connected to the panel by a flexible cable to permit testing the relay in various positions.

2. TESTS.

a. With the socket resting on the bench, plug in the sensitive relay in vertical position. Turn the line switch on and, while lightly tapping the socket stand, slowly increase the current by means of the "RELAY CURRENT" potentiometer until the pilot light comes on. Repeat with the socket so set that the relay is in various horizontal positions. If the pilot light fails to indicate relay operation when the current reaches the specified value (4.0 to 4.3 ma. for Model 103-2) regardless of position of the relay, the need of overhaul or adjustment is indicated.

CAUTION

Do not leave the line switch turned on when the test stand is not in use.

b. Apply a 500 volt, 60 cycle alternating current for a period of 10 seconds between each contact pin and the case or coil housing assembly. No failure of insulation should occur.

III OVERHAUL AND REPAIR PROCEDURE

1. PRELIMINARY TEST AND DIAGNOSIS.

a. Before beginning disassembly of a sensitive relay, perform the tests described in Section II to determine the condition of the device.

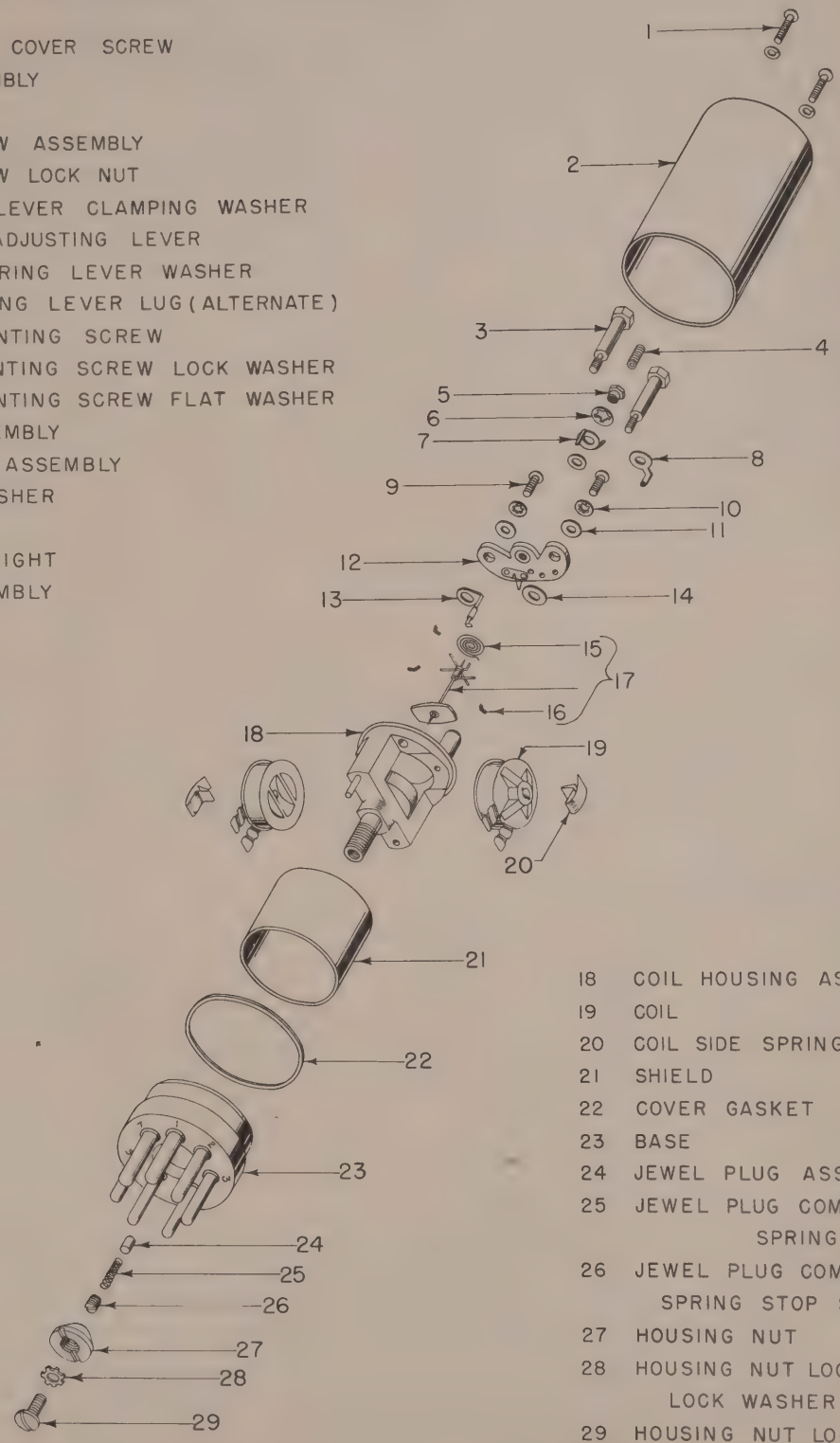
b. Sensitive relays which are functioning properly require no overhaul.

c. It is recommended that defective sensitive relays be returned to the factory for repairs. Such work should be attempted in the field only if a well equipped instrument repair shop staffed by trained instrument mechanics is available.

d. If a defective relay is to be repaired, proceed to disassemble the instrument to the point required to make the necessary inspections and additional tests to determine the cause of the trouble and to permit application of the remedy specified below.

TROUBLE	PROBABLE CAUSE	REMEDY
RELAY FAILS TO RETURN CIRCUIT TO NORMAL CONDITION WHEN NOT ENERGIZED	Incorrect hairspring adjustment.	Adjust hairspring.
	Upper jewel screw too tight.	Adjust jewel screw.
	Dirty or defective jewel.	Clean jewels or replace jewel screw or jewel plug assembly.
	Defective pivot.	Clean pivot or replace rotor assembly.
	Foreign matter on rotor.	Clean rotor and housing assembly.
	Bent contact wire.	Reshape contact wire.
	Deformed hairspring. (N. O. relay)	Reshape or replace hairspring.
	Welded contacts. (N. O. relay)	Replace bridge assembly.
	Shorted blue and orange leads. (N. O. relay)	Insulate or replace leads.
	Open blue or orange lead. (N. C. relay)	Resolder or replace lead.
RELAY FAILS TO FUNCTION WITH MAXIMUM SAFE TEST CURRENT	Incorrect hairspring adjustment.	Adjust hairspring.
	Upper jewel screw too tight.	Adjust jewel screw.
	Dirty or defective jewel.	Clean jewels or replace jewel screw or jewel plug assembly.
	Defective pivot.	Clean pivot or replace rotor assembly.
	Foreign matter on rotor.	Clean rotor and housing assembly.
	Bent contact wire.	Reshape contact wire.
	Open coil.	Replace coil.
	Open coil lead.	Resolder or repair lead.
	Coil to pin connection reversed.	Correct the connection.
	Welded contacts. (N. C. relay)	Replace bridge assembly.
	Shorted blue and orange leads. (N. C. relay)	Insulate or replace leads.
	Open blue or orange lead. (N. O. relay)	Resolder or replace lead.
RELAY FAILS TO OPERATE WITH RATED CURRENT	Incorrect hairspring adjustment.	Adjust hairspring.
	Upper jewel screw too tight.	Adjust jewel screw.
	Dirty or defective jewel.	Clean jewels or replace jewel screw or jewel plug assembly.
	Defective pivot.	Clean pivot or replace rotor assembly.

1 SELF-LOCKING COVER SCREW
2 COVER ASSEMBLY
3 POST
4 JEWEL SCREW ASSEMBLY
5 JEWEL SCREW LOCK NUT
6 HAIRSPRING LEVER CLAMPING WASHER
7 HAIRSPRING ADJUSTING LEVER
8 FLAT HAIRSPRING LEVER WASHER
HAIRSPRING LEVER LUG (ALTERNATE)
9 BRIDGE MOUNTING SCREW
10 BRIDGE MOUNTING SCREW LOCK WASHER
11 BRIDGE MOUNTING SCREW FLAT WASHER
12 BRIDGE ASSEMBLY
13 ROTOR STOP ASSEMBLY
14 SPACING WASHER
15 HAIRSPRING
16 BALANCE WEIGHT
17 ROTOR ASSEMBLY



18 COIL HOUSING ASSEMBLY
19 COIL
20 COIL SIDE SPRING
21 SHIELD
22 COVER GASKET
23 BASE
24 JEWEL PLUG ASSEMBLY
25 JEWEL PLUG COMPRESSION SPRING
26 JEWEL PLUG COMPRESSION SPRING STOP SCREW
27 HOUSING NUT
28 HOUSING NUT LOCK SCREW LOCK WASHER
29 HOUSING NUT LOCK SCREW

Figure 2—Exploded View of Model 103 Relay

2. DISASSEMBLY. (See figure 2.)

a. COILS.—To remove a defective coil, apply steps (1), (2), (3), (4), (5), (7), and (8) of paragraph *e.* below.

b. JEWEL SCREW ASSEMBLY.—The jewel screw assembly may be removed without unsoldering the hairspring from its adjusting lever if care is exercised to avoid distorting the spring while the jewel is out. Apply steps (5), (11), and (12) of paragraph *e.* below.

c. JEWEL PLUG ASSEMBLY.—With the rotor assembly removed by the procedure outlined in paragraph *d.* below, apply steps (1), (19), and (20) of paragraph *e.* to remove the jewel plug assembly.

d. ROTOR ASSEMBLY.—After following steps (5), (6), and (9) of paragraph *e.*, loosen the jewel screw lock nut and jewel screw sufficiently to release the upper pivot from the jewel. Tilt the rotor to one side and carefully withdraw it from the coil housing assembly.

e. COMPLETE PROCEDURE.

(1) Remove the housing nut lock screw from the center of the base.

(2) Unscrew and remove the housing nut from the center of the base.

(3) Dip the base contact pins into a pot of hot solder and gently lift cover with relay mechanism attached off of base as leads are loosened from the pins.

(4) Lift cover gasket from base, and with solder on pins softened by again dripping into solder pot, blow same out of pins by means of compressed air.

(5) Remove the two self-locking cover screws and withdraw cover assembly from relay mechanism.

(6) Remove brass posts from coil housing assembly.

(7) Slide shield off of lower end of mechanism.

(8) Lift coils off of coil housing assembly and pull coil side springs out of coils.

(9) Unsolder hairspring from hairspring adjustment lever.

(10) Unsolder flexible insulated leads from contact wire terminal and hairspring adjusting lever or adjusting lever lug.

(11) Remove jewel screw lock nut, hairspring lever clamping washer, hairspring adjustment lever and flat hairspring lever washer or lug.

(12) Remove jewel screw assembly.

(13) Remove two bridge mounting screws, lock washers and flat washers.

(14) Lift off bridge assembly, being careful not to damage contact wire.

(15) Remove rotor stop assembly and spacing washer.

(16) Lift out rotor assembly being careful not to damage hairspring.

(17) Remove balance weights by sliding off of balance cross.

(18) Unsolder inner end of hairspring and remove hairspring.

(19) Using small screwdriver, remove jewel plug compression spring stop screw from within hollow threaded stud at lower end of coil housing assembly.

(20) With a narrow punch, drive the jewel plug assembly and the compression spring out of the hollow stud. Both spring and jewel will be destroyed in this operation.

3. CLEANING, INSPECTION, TESTING, AND REPAIR.

a. BASE.—Check base for cracked plastic and loose or bent contact pins. Replace if defective.

b. COILS.—Using an ohmmeter, check resistance of coils. (Model 103-2 coils vary between 1.5 and 1.8 ohms.) Replace if open or out of tolerance.

c. HAIRSPRING.—Check hairspring to be sure its convolutions are approximately equidistant and in a plane at right angles to the rotor shaft. If necessary, gently bend the hairspring or replace with a new one.

d. JEWELS.—In cases of excessive friction, first attempt correction by adjusting, inspecting, cleaning and if necessary, replacing the jewel screw and jewel plug assemblies. Using a fine needle whose point has been stoned until it appears sharp under a microscope with 30X magnification, explore the lower portion of the jewel cavity for cracks or rough spots. Examine the jewel with 30X magnification for defects. Replace with new jewel screw or jewel plug assembly if jewel is defective. Clean jewel with a sharp pointed orange stick before reassembly.

e. PIVOTS.—With the rotor assembly removed from the coil housing assembly, inspect the pivots with 30X magnification. Worn or distorted pivots necessitate the replacement of the entire assembly. Clean pivots by inserting them in a piece of fernwood or pitch before replacing rotor assembly in mechanism.

f. ROTOR ASSEMBLY.—When the rotor assembly has been removed, inspect both it and the coil housing assembly to see that they are free from dust, lint and iron filings. A rotor assembly whose balance cross or magnet vane has become loosened must be replaced. The vane will not lose its magnetic strength due to disassembly, so remagnetizing should not be necessary.

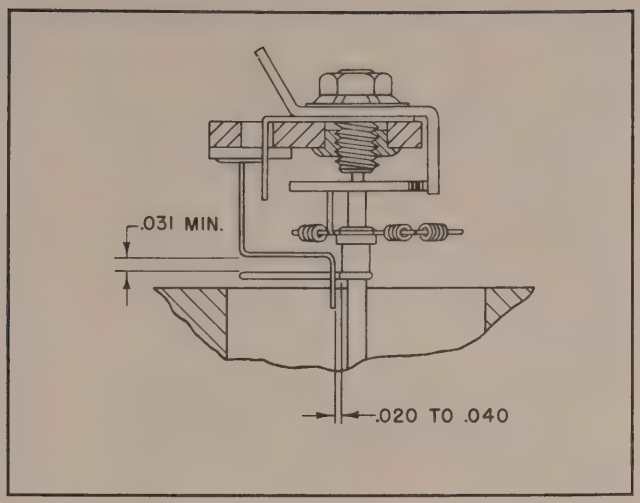


Figure 3—Position of Stationary Contact Wire

g. CONTACT WIRES. — Inspect contact wires for evidence of arcing or distortion. (See figure 3.) If wire is not in correct position, gently bend it into place. Defective contact wires necessitate the installation of a new bridge assembly.

h. BALANCE WEIGHTS. — If balance weights are loose on balance cross, remove them and bend them slightly.

4. REASSEMBLY.

a. REASSEMBLY PROCEDURE. (See figure 2.)

(1) Insert the jewel plug assembly into the lower end of the hollow threaded stud at the bottom of the coil housing assembly.

(2) Place jewel plug compression spring in stud behind plug.

(3) Screw jewel plug compression spring stop nut into threaded stud until spring is compressed tight, then back screw off ¼ to ½ turn.

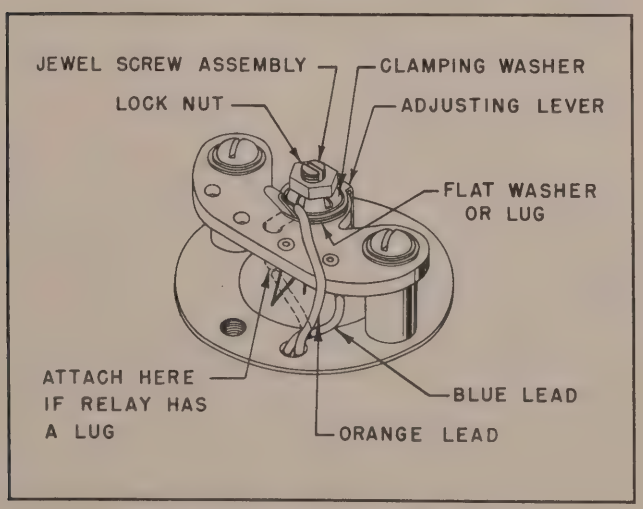


Figure 4—Detail of Bridge Region

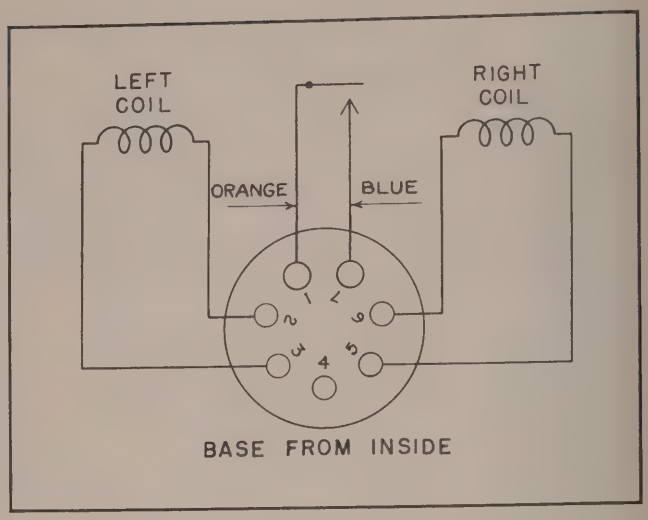


Figure 5—Contact Pin Connections

(4) Holding coil housing assembly in upright position with the hole for lead wires away from observer, place the rotor stop assembly on the left bridge support stud and the spacing washer on the right stud.

(5) Place the bridge assembly upon the studs with the contact wire on the same side of the studs as the lead wire hole.

(6) Pass the two bridge mounting screws through their lock washers and flat washers and secure the bridge to the studs therewith.

(7) Screw the jewel screw assembly into the bridge until the jewel is flush with the under side of the bridge assembly.

(8) Place the flat hairspring lever washer or lug, the adjusting lever and the clamping washer on the jewel screw. Secure with the lock nut. (See figure 4.)

(9) Solder the blue flexible insulated lead to the terminal of the stationary contact wire, and the orange lead to the terminal of the adjusting lever lug if this part is used on the relay undergoing repairs. Otherwise, the orange lead is soldered directly to the upturned end of the hairspring adjusting lever itself. (See figure 4.)

(10) Twist blue and orange wires together and pass downward through hole in coil housing assembly. If orange lead is soldered directly to the hairspring adjusting lever, rotate lever to extreme clockwise position before twisting leads.

(11) Place the coils in position upon the coil housing assembly.

(12) Press the coil side springs into place on the coils, the bent end being toward the bridge.

(13) Slide the shield up over the coil end of the coil housing assembly until it seats against the flange.

(14) Straighten the coil leads so that each projects straight downward one inch below the lower edge of the shield. If necessary, unwind leads from anchor lugs of coil, but leave at least two turns around lugs. Leads that are still too short may be spliced.

(15) Remove insulation from ends of leaks to within ½ inch of shield.

(16) With base positioned so that hole between #1 and #7 contact pins lines up with brass guide pin in bottom of coil housing assembly, slip base over hollow threaded stud, allowing leads to pass into and through their respective contact pins. (See figure 5.)

(17) Place housing nut on hollow threaded stud and tighten.

(18) Insert housing nut lock screw in hollow stud and screw tight.

(19) Clip leads off flush with ends of contact pins.

(20) Place cover assembly over mechanism to protect same from fumes, while dipping base contact pins ⅛" into hot solder in solder pot to secure leads to pins.

(21) With hairspring spiraling outward in a clockwise direction when viewed from above the rotor assembly, solder its inner end to the outside of the upturned end of the balance cross and flush with top of same. (See figure 6.)

(22) Grasp balance weights with tweezers in the position which will straighten them. They may then be slipped onto the arms of the balance cross which they will grip when released.

(23) Using care to avoid damaging hairspring, place the rotor in the coil housing assembly.

(24) Using tweezers, seat the lower pivot in the lower jewel, then tighten the upper jewel screw just sufficiently to seat the upper pivot within its cavity.

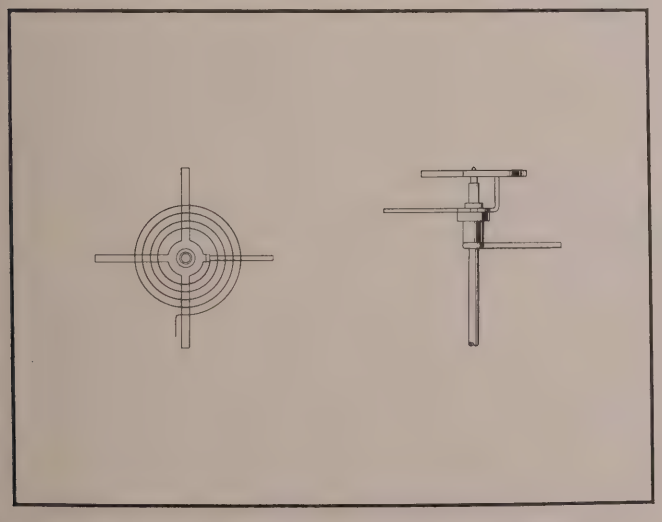


Figure 6—Position of Hairspring on Rotor

(25) Solder the outer turn of the hairspring to the hairspring adjusting lever, keeping the hairspring parallel to the bridge. (See figure 4.)

(26) Using Deolene or carbon tetrachloride, clean the rotor contact and the stationary contact wire.

Note

Remaining reassembly steps should follow Final Adjustment.

(27) Screw the two brass posts into the flange of the coil housing assembly.

(28) Place cover gasket on base flange.

(29) Slip cover assembly down over mechanism.

(30) Secure cover in place by means of self-locking cover screws.

b. ADJUSTMENTS.

(1) JEWEL SCREW.—Loosen jewel screw lock nut sufficiently to permit turning of jewel screw. Adjust to allow .001 to .0025 inch rotor end play, then tighten lock nut.

(2) CONTACT WIRE.—Bend the stationary contact wire or wires to the position shown in figure 3. Clean contact wire and rotor contact with Deolene or other suitable cleaner.

(3) HAIRSPRING POSITION.—Adjust hairspring so that its convolutions are approximately equidistant and in a plane at right angles to the rotor shaft.

(4) HAIRSPRING TENSION. — Place relay in socket of the test stand described in Section II and with same resting on table with relay in vertical position, adjust current to specified coil rating. (Model 103-2 requires 4.0 to 4.3 ma.) Move hairspring adjusting lever until relay makes contact. Alternately decrease and increase the current while adjusting hairspring tension until operation is within tolerance while socket stand is being lightly tapped.

(5) ROTOR BALANCE.

(a) Adjust current to turn rotor until balance cross side arms are in line with bridge supporting studs. Tip relay 90° forward to horizontal position, and holding socket stand upon top of test stand cabinet or other solid support, adjust side balance weights to cause rotor to remain in position with side arms in line with studs.

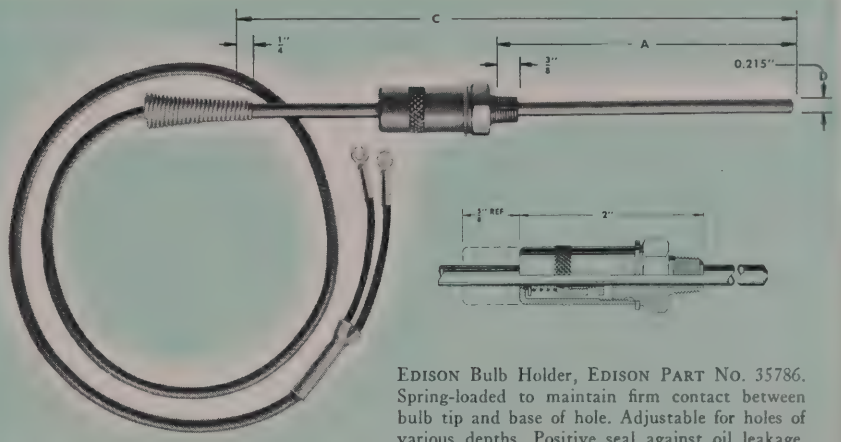
(b) With relay still in horizontal position, rotate it 90°. Adjust center balance weight to cause rotor to assume position with side arms in line with studs.

(6) FINAL ADJUSTMENT.—Repeat the tests described in Section II paragraph 2, adjusting hairspring tension and rotor balance until operation is within specified tolerance.

Edison ip-sensitive resistance bulbs

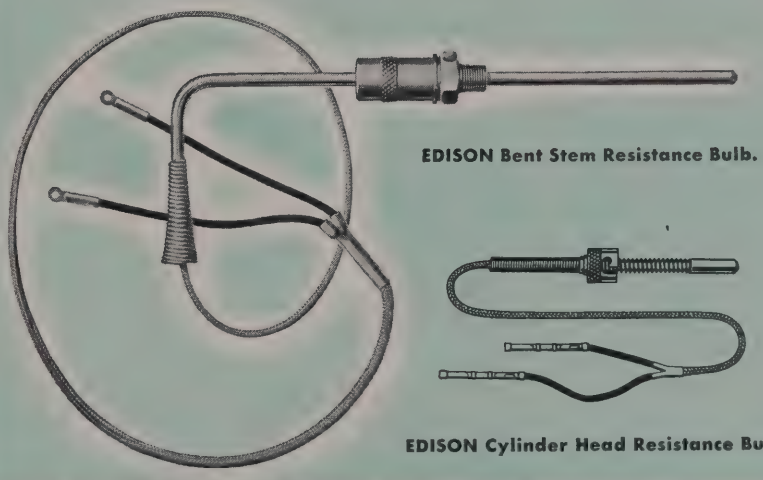
EDISON Tip-Sensitive Resistance Bulbs have their sensitive portion confined to an extremely small area at the tip of the stem. These tip-sensitive bulbs are used to probe deep into a bearing or other solid to measure the actual temperature at the particular point touched. Intimate contact between sensitive tip and solid material is maintained with a spring-loaded adjustable holder.

EDISON Straight Stem Tip-Sensitive Electrical Resistance Thermometer Bulb, EDISON PART NO. 35195, with Holder, EDISON PART NO. 35786. *Material:* Stainless Steel. *Standard Lengths of Stem* (C): 5", 7½", 10", 12½" and 15". *Diameter of Stem* (D): 0.215". *Working Length* (A): Adjustable up to 2½" less than stem length. *Leads:* 2 ft. Std. Lgth.



EDISON Bulb Holder, EDISON PART NO. 35786. Spring-loaded to maintain firm contact between bulb tip and base of hole. Adjustable for holes of various depths. Positive seal against oil leakage. Mounting thread: ⅛" pipe.

In addition to the straight stem bulbs described above, EDISON Tip-Sensitive Resistance Bulbs are available on special order in other lengths, and with bent stems, or equipped with bayonet mounting. Other values of resistance are also obtainable.



EDISON Bent Stem Resistance Bulb.

EDISON Cylinder Head Resistance Bulb.

CHARACTERISTICS OF EDISON TIP-SENSITIVE RESISTANCE BULBS

Working Temperature Range: From —100° F. to +600° F.

Temperature Sensitive Wire Element: Variable resistance wire sealed into tip of housing.

Manufacturing Standards: Produced with an accuracy of 1% over entire working range to a standard curve which will be furnished on request.

THOMAS A. EDISON, INCORPORATED
INSTRUMENT DIVISION
WEST ORANGE, NEW JERSEY, U. S. A.

BLICATION NO. 3016

(OVER)

EDISON electrical resistance thermometer bulbs

Electrical resistance thermometer bulbs are used as sensing elements for temperature indicating, recordi control or alarm systems. They may be placed at considerable distance from a recording device, and connected to it by ordinary copper wire. They avoid the use of capillary tubes and sealed liquid systems.

METHOD OF OPERATION

When the medium surrounding a bulb gets hotter or colder, the temperature of the bulb rises or falls, and its resistance to the flow of electric current increases or decreases. This changes the current flow through the receiving device and causes a pointer to indicate temperature, a control to operate, an alarm to sound, or some other act to be performed.

NO MOVING PARTS

Edison Electrical Resistance Thermometer Bulbs are dependable, rugged, capable of continuous operation under adverse conditions, and need no maintenance.

TWO GENERAL TYPES

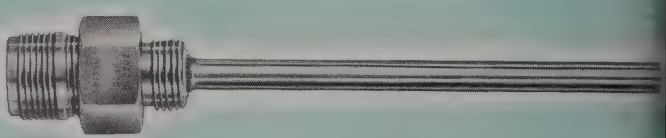
There are two general types of Edison Electrical R sistance Thermometer Bulbs . . . Tip-Sensitive and Ste Sensitive.

In the Stem-Sensitive type, the sensitive portion tends for a considerable distance lengthwise inside t stem. When immersed in a solid, liquid, or gas, this bu responds promptly to the average temperature preva ing along the stem.

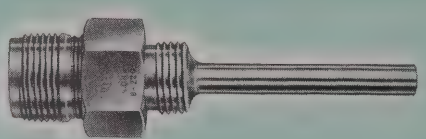
In Tip-Sensitive bulbs, only the tip is sensitive temperature changes. This type is best suited for pro type applications, such as the measurement of bear temperature, or aircraft engine cylinder head temp atures.

EDISON STEM-SENSITIVE RESISTANCE BULBS

These are averaging type bulbs, widely used by the aeronautical industry to measure the temperatures of oil, coolant, and carburetor air. They are available with long or short stems and exceed Army-Navy specification requirements in speed of response and ability to operate continuously at high temperatures, as will be noted below, yet their price is competitive.



EDISON Long Stem-Sensitive Electrical Resistance Thermo Bulb. EDISON PART NO. B2202 (F.S.S.C. No. 88-B-895) (AN5525-2). *Material:* Stainless Steel. *Length of Stem:* 4". *Diame Stem:* ¼". *Mounting Thread:* ⅜-18. *Receptacle:* Type RC-AND 10



EDISON Short Stem-Sensitive Electrical Resistance Thermo Bulb. EDISON PART NO. B2201 (F.S.S.C. No. 88-B-890) (AN5525-1). *Material:* Stainless Steel. *Length of Stem:* 1⅞". *Diame Stem:* ¼". *Mounting Thread:* ⅜-18. *Receptacle:* Type RC-AND 10

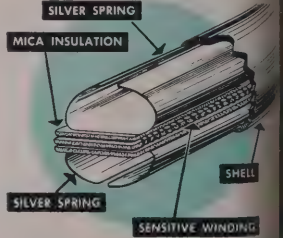
Characteristics of EDISON Stem-Sensitive Resistance Bulbs

Speed of Response: Time constant 1¼ seconds in stirred water bath.

Working Temperature Range: From —100° F. to +600° F.

Temperature-Sensitive Wire Element: Variable-resistance wire of high-purity nickel, sealed in stem.

Manufacturing Standards: Produced in accordance with Army-Navy Specification AN-B-19, Amendment #2. Resistance of all bulbs will conform within 1% over entire working range to the standard nickel curve included therein.



Cutaway view of Edison AN Bulb stem, showing patented silver thermal conductor spring that provides faster response than required by AN specifications and acts as an excellent cushioning against shock.

THOMAS A. EDISON, INCORPORATED
INSTRUMENT DIVISION
WEST ORANGE, NEW JERSEY, U. S. A.

PUBLICATION NO. 3016

(OVER)

EDISON

GENERAL DESCRIPTION

ELECTRICAL RATIO RESISTANCE THERMOMETERS

WITH TYPES A, B, R AND RH

THERMOMETER INDICATORS

Thomas A Edison

INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

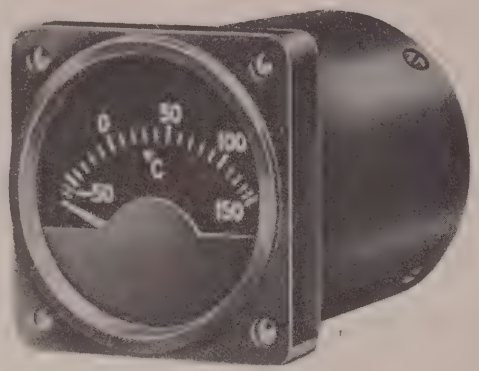
WEST ORANGE, NEW JERSEY, U. S. A.

No. 1006

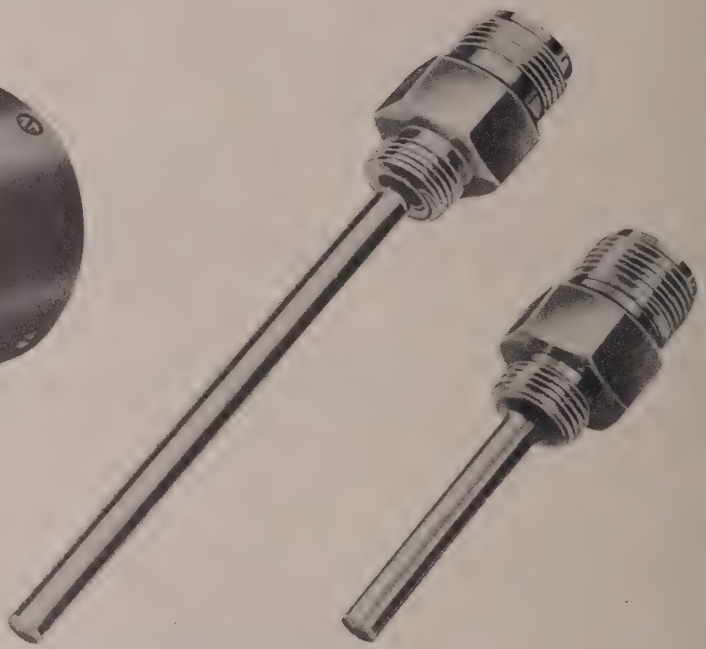
Printed in U.S.A.

November 1, 1946

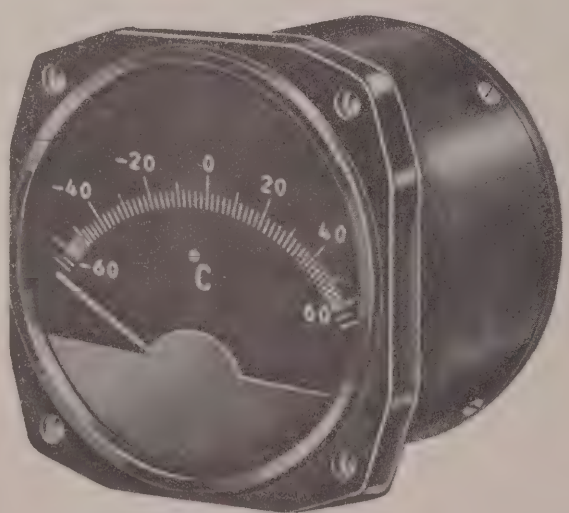
EDISON ELECTRICAL RATIO RESISTANCE THERMOMETERS



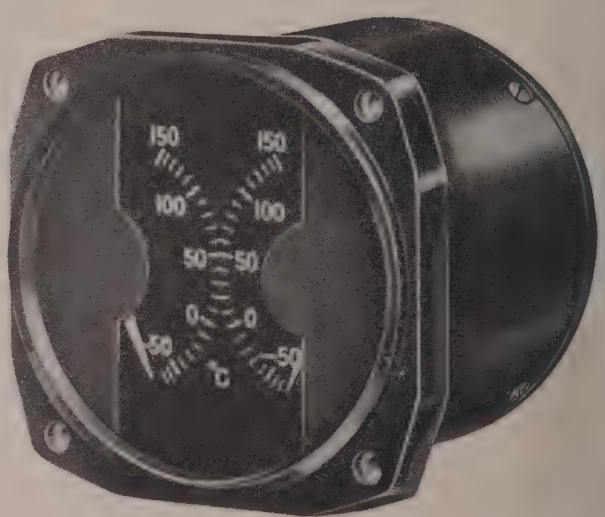
SMALL SINGLE INDICATOR



TYPICAL RESISTANCE BULBS



LARGE SINGLE INDICATOR



DUAL INDICATOR

Figure 1—Major Parts of the Thermometer System

ELECTRICAL RATIO RESISTANCE THERMOMETERS

WITH

EDISON

TYPES A, B, R AND RH

THERMOMETER INDICATORS

I INTRODUCTION

(Refer to Figure 1.)

The Ratio Resistance Thermometer consists of three main parts: a resistance bulb, or in dual installations two bulbs, installed at the point where the temperature is to be measured; the indicator which is placed where the reading is to be shown; and the necessary connecting wiring between the bulb or bulbs and the indicator. Power to operate the system may be furnished by any available source of direct current of the required voltage.

RESISTANCE BULBS.—Several styles and sizes of temperature-sensitive bulbs are available, each being particularly adapted to a given class of installation. Those illustrated* are typical of the style used to measure the temperature of carburetor air or mixture, free air, cabin air, heating ducts, engine oil or coolant in aircraft installations. The electrical characteristics of the two are identical. For the measurement of cylinder-head temperature in air-cooled engines a different style of bulb is required. The electrical characteristics of these bulbs differ from those of the style illustrated so they can not be used with the same indicators.

INDICATORS.—Edison Thermometer Indicators are made in several types, each of which is available in two sizes of single and one size of dual instrument.

Type R indicators are designed for use with AN5525 bulbs only. Provision is made for connecting them to either a 14- or 28-volt d.c. power supply. External wiring follows the standard Army-Navy circuit, a common grounded lead connecting dual indicators to both bulbs.

Type RH is similar in all respects to Type R except that models are available for use with various cylinder head resistance bulbs rather than the AN5525 bulbs.

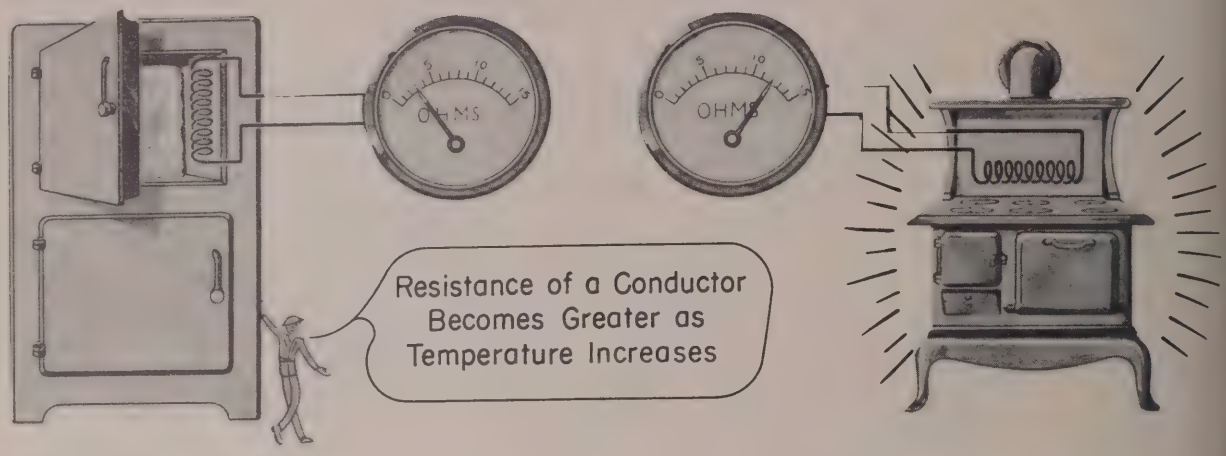
Type B is made both in models similar to Type R and Type RH, the only difference being that the mounting flange contains a transparent plastic layer to ring-light the dial by means of a back-panel light box.

Type A is available both in models for AN5525 bulbs and cylinder head bulbs. Connectors, however, provide for operation from a single voltage only, and dual instruments are wired with entirely separate circuits to the two bulbs.

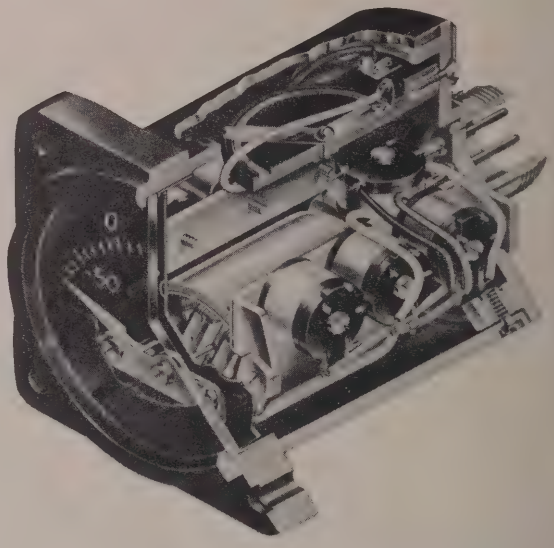
CONNECTING WIRING.—Connection between the bulb and the indicator is made with ordinary insulated copper wire terminated in connector plugs to fit the instrument receptacles. Because either bulb or indicator can be removed from the circuit for overhaul or replacement without affecting the calibration of the system, wiring may be made a permanent installation.

*Army-Navy Bulb No. AN5525-1 and AN5525-2 as made by Edison-Splitdorf Corporation under their numbers B2201 and B2202 respectively.

EDISON ELECTRICAL RATIO RESISTANCE THERMOMETERS



DISASSEMBLED BULB



CUT-AWAY VIEW OF INDICATOR

TEMPERATURE / CENTIGRADE	0° FREEZING	20°	40°	60°	80°	100° BOILING
RESISTANCE / OHMS	90.38	97.31	104.60	112.28	120.36	128.85

Figure 2—General Principles of Resistance Thermometry

II BASIC PRINCIPLE OF RESISTANCE THERMOMETRY

(Refer to Figure 2.)

The fact that the electrical resistance of a metal becomes greater as its temperature increases is the basis of the electrical resistance type thermometer. To construct such an instrument in the laboratory, a metallic conductor is brought to whatever temperature is to be the minimum point on the scale and its resistance is measured. Step by step the temperature is increased and the corresponding resistance is noted. Thus a table of degrees of temperature and corresponding resistance is built up for the particular conductor in question. Thereafter whenever it is desired that the temperature of the conductor be ascertained, it is only necessary to measure its resistance and convert the reading into degrees of temperature. This is readily done by having the dial of the resistance indicator calibrated directly in either Fahrenheit or Centigrade degrees.

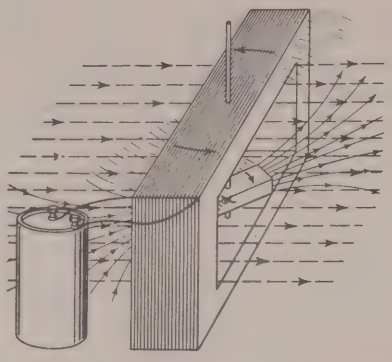
III BULBS AND INDICATORS

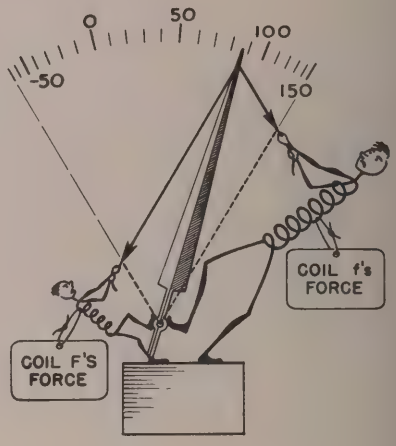
(Refer to Figure 2.)

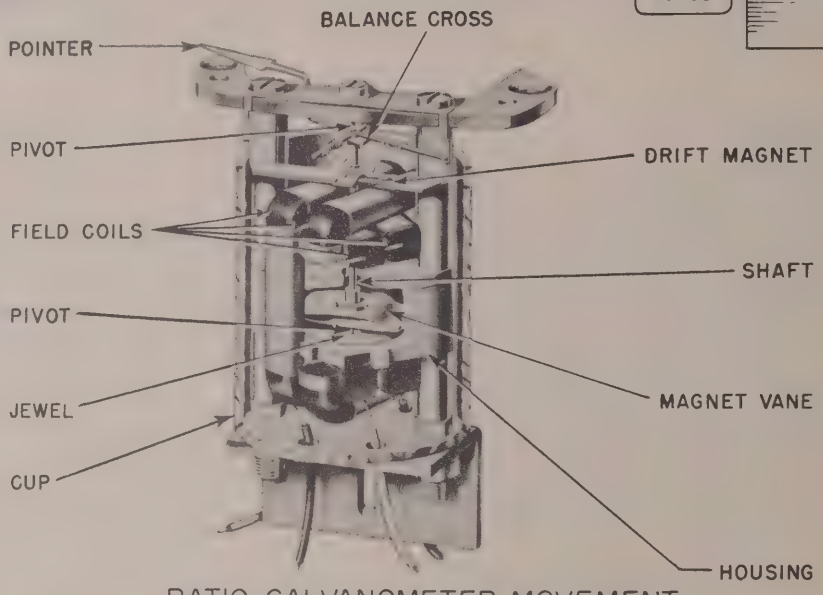
For practical reasons it is necessary to mount the temperature-sensitive conductor within a protective housing. The complete assembly forms the resistance bulb. Although bulbs vary in design depending upon the manufacturer and the type, provision must always be made for the rapid transmission of heat from the medium whose temperature is to be measured to the winding. In the bulb illustrated, silver heat conductors resting against thin mica insulators on each side of the winding press against the inner surface of the stainless steel bulb stem for this purpose. To make bulbs of a given type interchangeable, standard temperature-resistance characteristics have been adopted. The illustration, which is taken from Army-Navy Specification AN-GG-B-796 for bulbs AN5525-1 and AN5525-2, shows part of such a table.

The resistance-measuring indicator contains a galvanometer movement and the necessary resistors to form a bridge circuit, all housed within a suitable case. Each indicator is designed specifically for use in connection with bulbs having a particular temperature-resistance characteristic and can be used with that type of bulb only. The circuit is so designed that the instrument is self-compensated to be unaffected by ambient temperature changes. The ratio galvanometer and its associated ratio bridge circuit, although somewhat more complex than the Wheatstone bridge and simple galvanometer, has several important advantages. It operates accurately over a comparatively wide voltage range, hence length of connecting wire and normal power fluctuations are negligible factors. Another advantage lies in the fact that the pointer may readily be arranged to swing off the lower end of the scale to show power supply failure.

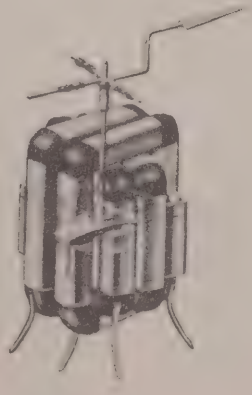
EDISON ELECTRICAL RATIO RESISTANCE THERMOMETERS







RATIO GALVANOMETER MOVEMENT



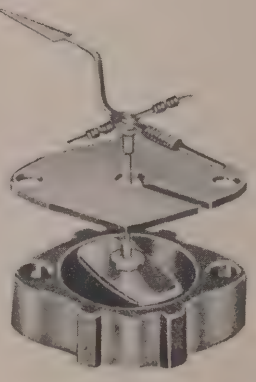


Figure 3—Edison Ratio Galvanometer Movement

IV THE EDISON RATIO GALVANOMETER MOVEMENT

(Refer to Figure 3.)

Like all galvanometer movements, the operation of the Edison ratio galvanometer is based upon three fundamental physical principles. First, when a current flows through a coil of insulated wire, invisible lines of magnetic force flow through and around the coil at right angles to the wire, the strength of the magnetic field thus formed being in proportion to the current flowing. Second, a similar magnetic field surrounds a permanent magnet at all times. Third, when a permanent magnet and a magnetic coil are so placed that their fields overlap, both will tend to rotate to such a position that their lines of force coincide.

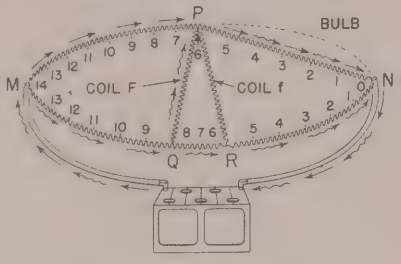
Ratio movements are constructed with two magnetic coils and a permanent magnet. Either the coils or the magnet may be free to rotate and swing the pointer over the dial. In the Edison ratio movement, the magnet vane is pivoted within the two pairs of stationary field coils. These coils are so placed that the lines of force through one pair tend to turn the vane with its attached pointer toward the high end of scale, while those of the other coil rotate it to the low end. This design has the advantage of eliminating the necessity for current-carrying hairsprings. Because the pointer position is the resultant of the two opposing magnetic fields rather than an absolute measure of either, a proportional increase or decrease in the current through both, such as results from power supply voltage fluctuation, does not affect the indication.

The movement is so arranged that the pointer will swing off the low end of the scale if the voltage supply to the circuit fails. This is accomplished by a drift or pull-off magnet which is mounted on a bracket immediately above the field coils.

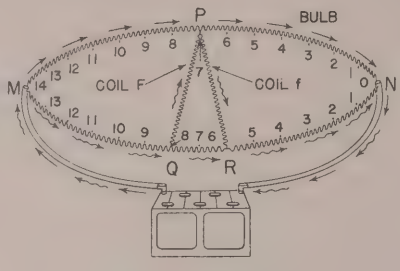
In order to prevent oscillation of the rotor, as it moves to a new position with a variation in the ratio of the current through the field coils, some damping method is required. This is achieved by placing the vane inside a copper housing. As the vane turns, its magnetic lines of force cut the copper housing causing a minute current to flow around the housing as if it were a coil. This current sets up a magnetic field which opposes that of the vane, thus bringing the rotor to a stop as it reaches the point at which the forces of the two coils are equal.

The various magnetic fields of the galvanometer would tend to react with those of nearby instruments or magnetic materials if the movement were not shielded in some manner. For this purpose, a highly permeable metal cup is placed around the movement.

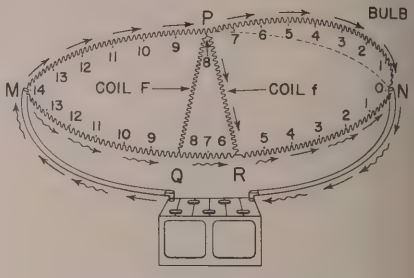
EDISON ELECTRICAL RATIO RESISTANCE THERMOMETERS



MINIMUM BULB RESISTANCE

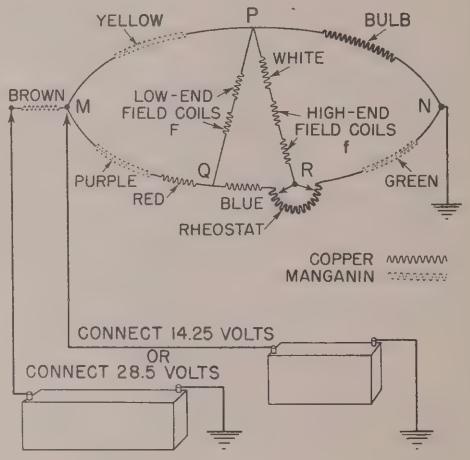


INTERMEDIATE BULB RESISTANCE

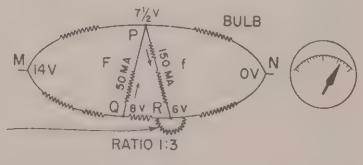


MAXIMUM BULB RESISTANCE

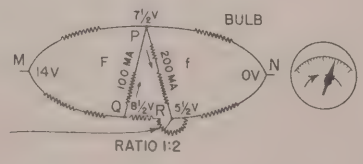
RATIO BRIDGE CIRCUIT



SCALE SPAN ADJUSTMENT

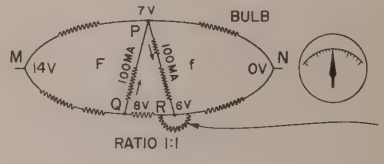


RATIO 1:3

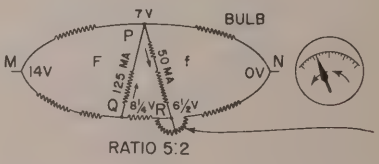


RATIO 1:2

POINTER POSITION ADJUSTMENT



RATIO 1:1



RATIO 5:2

Figure 4—Edison Ratio Bridge Circuit

V THE EDISON RATIO BRIDGE CIRCUIT

(Refer to Figure 4.)

Like all other resistance-measuring circuits, the ratio bridge operates on the principle that the amount of current flowing through a conductor depends upon the voltage trying to force the current along, and the resistance trying to hold it back.

In the Edison ratio bridge circuit the two galvanometer field coils F and f are connected across the branches of a divided circuit. The various resistors of the circuit are so adjusted that when the bulb, represented by the P-N portion of the circuit, is at its minimum working temperature the voltage at points P and R are the same. As the temperature of the bulb increases, its resistance rises correspondingly, causing an increase in the voltage at P. This causes a larger amount of current to flow downward through coil f and a smaller amount to flow upward through F. When the bulb reaches its maximum working temperature, the voltage at point Q is equal to that at P. Under these conditions no current will flow through coil F while that through coil f will be at its maximum.

Any fluctuation in the voltage applied across points M and N will cause a proportional change in the voltage at every point in the circuit, so will not affect the ratio between the currents flowing through the two field coils.

Scale span and pointer position, or zero adjustment, are provided by placing a two-arm rheostat at point R. Increasing the resistance of the Q-R position of the circuit raises the voltage at Q and reduces it the same amount at R, thus equally increasing the current through the two field coils. This makes the ratio between their currents smaller, thus moving the pointer toward mid-scale from any previous position, hence narrowing the scale span. On the other hand increasing the resistance of the R-N position of the circuit raises the voltage at both points Q and R, thus increasing the current through coil F and decreasing that through f. By this means the pointer may be moved toward the low end of the scale from any position.

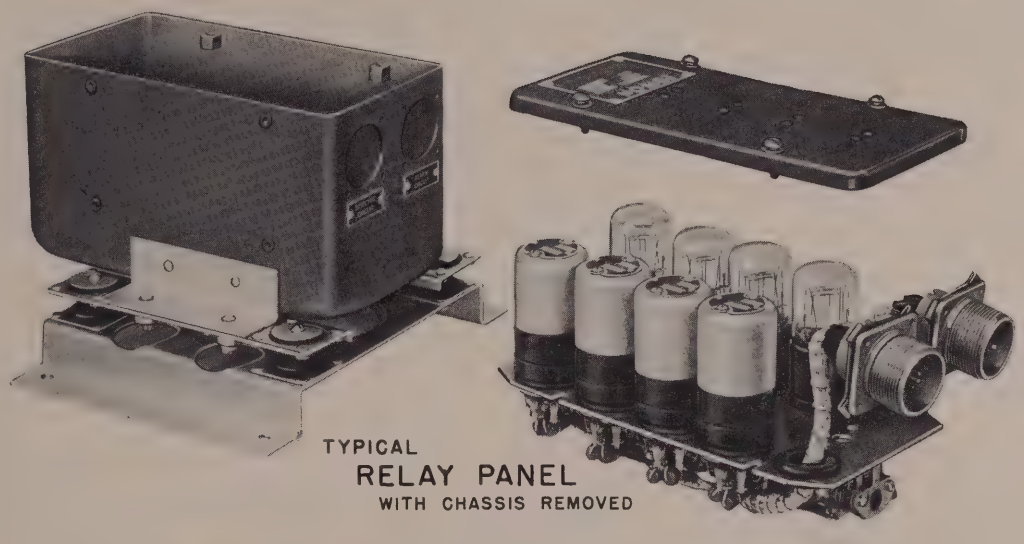
By the use of both manganin- and copper-wound resistors in the various parts of the circuit, the indicator is self-compensated to avoid incorrect readings due to ambient temperature changes. The "white" resistor is placed in series with one set of field coils to equalize their magnetic effect with that of the other set. The "brown" resistor is a voltage dropping resistor used when 28 volts is applied, since the bridge circuit is designed to operate on 14 volts direct current.

OVERHAUL MANUAL

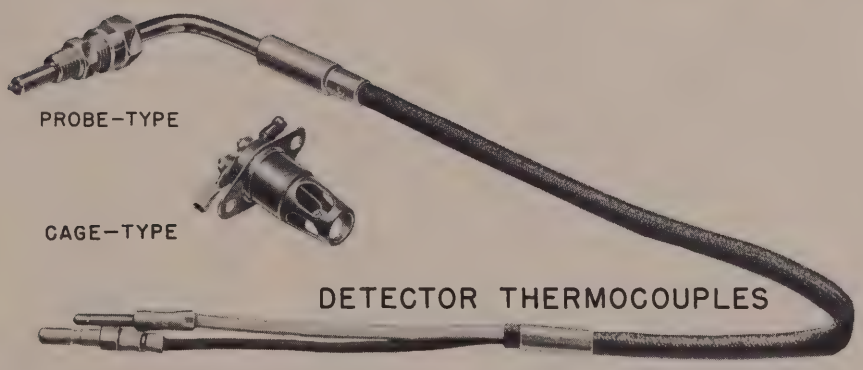
FOR

AIRCRAFT FIRE DETECTION SYSTEM

TYPE A



TYPICAL
RELAY PANEL
WITH CHASSIS REMOVED



INSTRUMENT DIVISION

THOMAS A. EDISON, INCORPORATED

WEST ORANGE, NEW JERSEY, U. S. A.

I INTRODUCTION

This Overhaul Manual is applicable to all Type A Aircraft Fire Detection Systems manufactured by the Instrument Division, Thomas A. Edison, Incorporated, West Orange, New Jersey, U. S. A. For description and operating principles refer to Publication No. 1021, and for line maintenance instructions see Publication No. 1022.

When Service Inspection, as outlined in the Line Maintenance Manual, has shown that a sensitive relay or relay panel is faulty, it should be removed from the aircraft to a properly equipped instrument repair shop where the tests described in Section II of this manual should be applied to determine the cause of the trouble.

Relay panels listed below are covered herein, schematics being shown on the pages indicated.

ONE CIRCUIT		
MODEL	PART	PAGE
117-13	34368	7
117-23	34599	7

THREE CIRCUIT		
MODEL	PART	PAGE
117-10	34216	11
117-10s	34216-2	11
117-17	34466	12
117-17s	34466-4	12
117-24	34466-2	13
117-29	34466-3	11
117-53	35472-1	11

TWO CIRCUIT		
MODEL	PART	PAGE
117-7	33961	8
117-14	34672	8
117-21	34559	8
117-22	34972-2	8
117-26	34972	8
117-27	34973	8
117-28	34974	8
117-31	34362-2	8
117-31X	34362-2	8
117-33	34974-2	8
117-35	34974-3	9
117-36	34974-4	9
117-37	34972-3	9
117-38	34972-4	9
117-39	34973-2	9
117-41	34362-3	9
117-41A	35883	9
117-50	34973-3	9
117-52	34974-5	9
117-52A	35884	9
117-62	34974-6	10
117-62A	35886	10
117-212	35882	9

FOUR CIRCUIT		
MODEL	PART	PAGE
117-4	33896	14
117-5	33958	14
117-6	33959	14
117-9	33242	14
117-15	34399	14
117-20	34726	14
117-32	34364-2	14
117-32X	34364-2	14
117-34	34399-3	15
117-40	33896-3	14
117-42	34364-3	14
117-44	33896-2	14
117-46	33959-3	14
117-49	34242-3	14
117-54	34726-2	14
117-55	33958-2	14
117-55s	33958-3	15
117-64	34726-4	16
117-66	33959-2	14
117-99	34242-2	14
117-1422	34978	16
117-1423	34726-3	17
117-1424	34978-2	17
117-1441	34399-2	18
117-1442	34726-5	18

SIX CIRCUIT		
MODEL	PART	PAGE
117-16	34398	19
117-30	34958	19
117-43	34958-2	20
117-47	35213	19
117-51	34958-3	21
117-56	35213-2	22

EIGHT CIRCUIT		
MODEL	PART	PAGE
117-19	34737-1	23
117-25	34737-2	24
117-45	35148-2	24
117-48	35148	23
117-58	35469	23

II - TEST PROCEDURE

2-1. TEST EQUIPMENT.

2-2. To facilitate the testing of the various units of the system, it is recommended that test boards similar to those shown and described below be constructed

and made part of the permanent shop equipment. It is recommended that separate boards be provided for testing 14 volt and 28 volt systems.

2-3. To guarantee proper operation of the units under low-voltage conditions in the aircraft, the test boards are operated at 10.5 or 22.5 volts dc rather than 14.25 or 28.5 volts.

2-4. THERMAL TEST UNIT AND SENSITIVE RELAY TEST BOARD. (See figure 1.)

2-5. For the construction of this apparatus, in addition to materials ordinarily stocked, the following parts are required;

1 Switch--S.P.S.T.
1 Switch--Momentary Contact, D.P.D.T.
1 Potentiometer--2 watt, 500 ohm, complete with knob
1 Socket--4-pin (Edison No. NA13137)
1 Socket--7-pin (Edison No. NA13136)
1 Resistor--2 watt, 100 ohm for 14-volt board or 10 watt, 200 ohm for 28-volt board
1 Relay--D.P.S.T. (Edison No. NA13336 for 14-volt board or NA13197 for 28-volt board)
1 Light--Bull's-eye, with 14 or 28 volt lamp as required
1 Resistor-- 2 watt, 1400 ohm for 14-volt board or 2800 ohms for 28-volt board
1 Meter--10 Milliamperes (resistance not to exceed 10 ohms)
1 Resistor--of necessary resistance to total 10 ohms when added to meter resistance

2-6. The 7-pin sensitive relay socket is mounted on a square base and connected to the panel by a flexible cable to permit the relay to be tested in various positions.

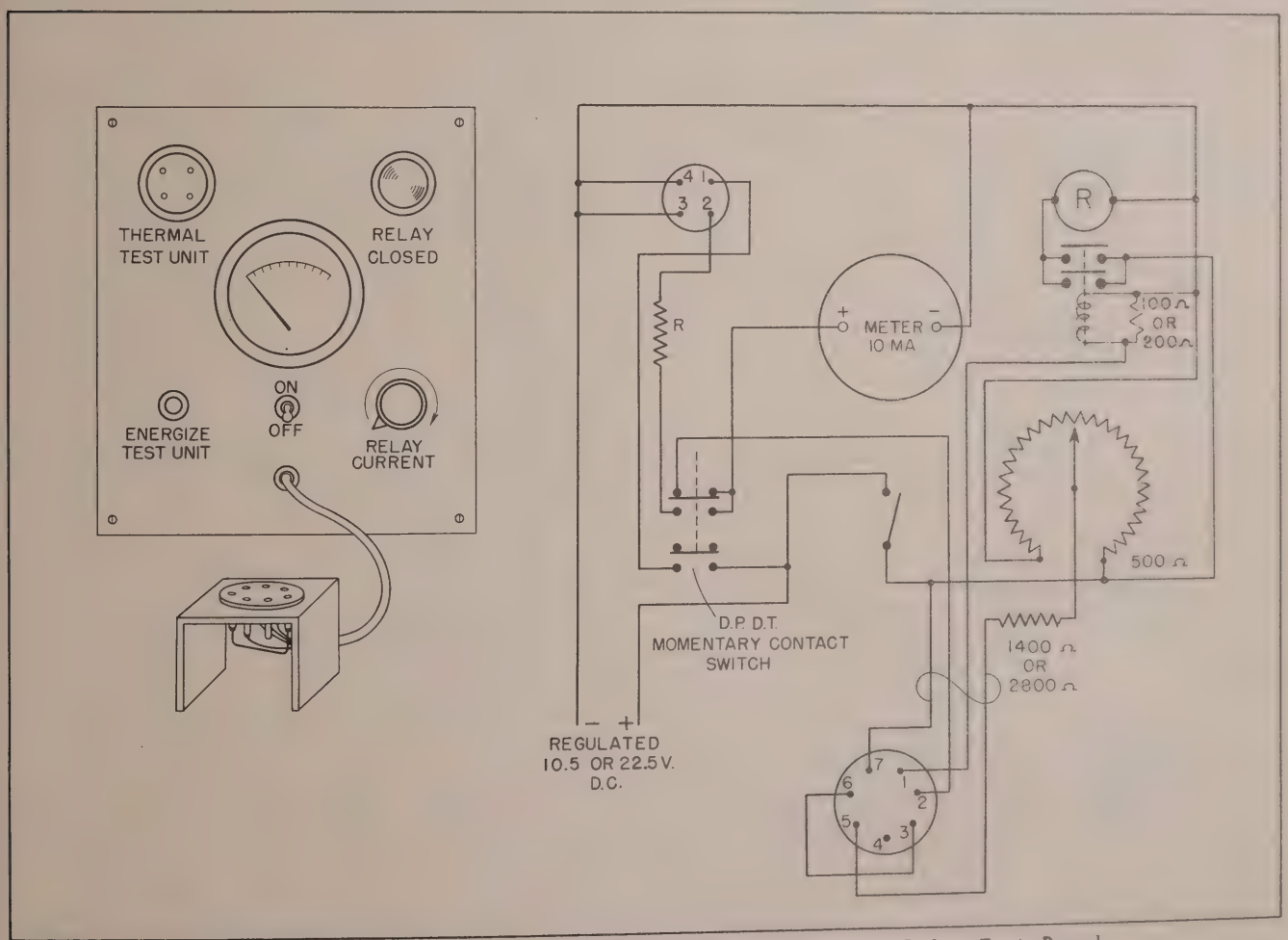


Figure 1 - Suggested Thermal Test Unit and Sensitive Relay Test Board

2-7. RELAY PANEL TEST BOARD. (See figure 2.)

2-8. This device simulates the power, test switch, and alarm circuits of the airplane, thus making it possible in the shop to check the operation of the relay panel and its components.

2-9. A detector circuit test plug is made up to fit each model panel which is to be tested. This consists of the proper AN3106 plug with each pair of detector circuit terminals connected together through a 5 ohm resistor. See applicable panel wiring diagram for receptacle contact layout.

2-10. By using the proper one of a set of cables, various models of relay panels may be tested on a single test board. One end of the cable is terminated in a socket-type plug to fit the alarm circuit receptacle of panel to be tested. The other end is provided with a pin-type plug to fit the test board receptacle. A few models of relay panels have detector connectors which carry other circuits in addition to those serving thermocouples. In such cases, these contacts must also be connected to the test board receptacles.

2-11. The following parts, in addition to those normally stocked, will be required to construct the test board and its accessories.

1 Switch--Mometary Contact, S.P.S.T.
9 Lights--Bull's-eye, with 14 or 28 volt bulbs as required
1 Receptacle--Type 3102-20-11S
Plug(s)--Type AN3106-20-11P
Plugs--Type AN3106 to mate with pin receptacles of panel(s) to be tested
Resistors--5 ohm, 2 watt as required

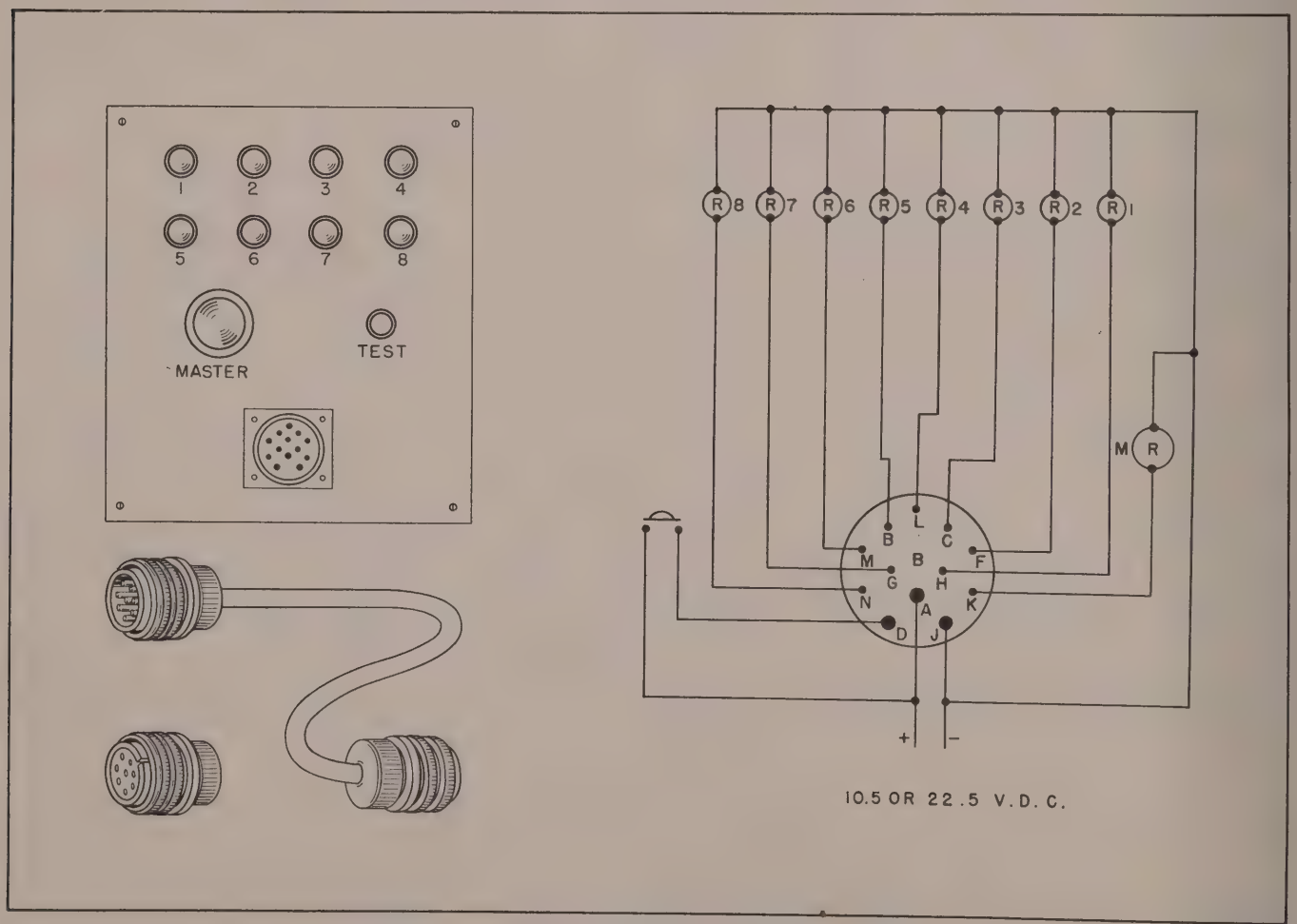


Figure 2 - Suggested Relay Panel Test Board

2-12. One to eight-circuit relay panels may be tested on the board shown in figure 2. If the maximum number of circuits served by the relay panels to be tested is less than eight, the number of lights may be reduced accordingly and a connector receptacle and plug with fewer contacts substituted for those listed.

2-13. TESTS.

2-14. GENERAL. Unless otherwise specified, all tests herein described are to be made at normal room temperature, 20°C to 30°C (68°F to 86°F), and normal atmospheric pressure of approximately 30" of mercury.

2-15. DETECTOR THERMOCOUPLES.

a. CONTINUITY TEST. Allow detector to stabilize to room temperature for at least an hour after which measure resistance between terminals. Resistance of probe type thermocouple should be 1.05 ohms ± 15%, while that of cage type should not exceed 0.09 ohms.

b. GROUND TEST - MODEL 108-6 ONLY. Resistance between either terminal and the mounting fitting must be zero.

c. INSULATION TEST - PROBE TYPE DETECTORS OTHER THAN MODEL 108-6. Apply a potential of 500 volts, RMS, 60 cycle ac or 500 volts dc between either terminal and the mounting fitting. Resistance must be not less than 10 megohms.

d. PRESSURE TEST - PROBE TYPE DETECTORS. Apply a pressure of 90" of mercury for a period of ten minutes to tip and mounting fitting. No leakage shall be indicated.

2-16. RELAY PANEL.

2-17. Test panel with thermal test units and sensitive relays in place as follows.

a. Insert detector circuit test plug in proper receptacle of panel.

b. Connect panel to test board by means of proper cable. Be sure supply voltage is correct for testing panel involved. (10.5 volts for 12 or 14-volt panel or 22.5 volts for 24 or 28.5-volt panel.)

c. Energize test circuit until all pilot lights served by panel have lighted.

d. Lights should be on within 10 seconds, but not before operation of switch.

2-18. Test defective circuits as follows.

a. With panel still connected to test board, remove sensitive relay and thermal test unit from defective circuit.

b. Short circuit the #1 and #7 terminals of the sensitive relay socket.

c. Failure of the pilot light to operate when so tested indicates a defective slave relay or wiring.

d. Check resistance between #1 contact of each sensitive relay socket and chassis (ground).

e. An open slave relay coil or arc-quenching resistor will result in a resistance of over 60 ohms in 12 or 14-volt panels or over 175 ohms in 24 or 28.5 volt panels.

NOTE

An open arc-quenching resistor is likely to cause welding of sensitive relay contacts.

2-19. THERMAL TEST UNIT.

a. Be sure power supply is correct for unit being tested (22.5 volts for 24 volt unit or 10.5 volts for 12 volt unit).

b. Turn on the switch marked ENERGIZE TEST UNIT and note reading.

c. Within 15 seconds output should reach a minimum of 50 millivolts (5 on meter's original scale).

d. Faulty units should be scrapped, since repair is not practical.

2-20. SENSITIVE RELAY.

a. Apply a potential of 500 volts, 60 cycle ac for a period of 10 seconds between each contact pin and the cover of the relay. No failure of insulation should occur.

b. Place relay in socket of test stand with socket resting on table so that relay is in vertical position.

c. Turn line switch on.

d. Increase the sensitive relay field current from 0 to 10 milliamperes at a rate of approximately 1/2 milliampere per second and note current value at instant relay operates as shown by pilot light.

e. Decrease current at above rate to be sure pilot light goes out before current drops to 3.0 milliamperes.

f. Repeat steps d and e with relay inverted and in each of four horizontal positions.

g. Pilot light should come on without flicker when meter reading is 4.0 to 4.6 milliamperes and no reading should vary from any other reading by more than 0.3 milliamperes regardless of relay position.

h. Failure of relay to operate within tolerances indicates need for adjustment or overhaul. (See Publication No. 1025.)

CAUTION

Do not leave the line switch turned on when test board is not in use.

III OVERHAUL AND REPAIR PROCEDURE

3-1. PRELIMINARY TESTS AND DIAGNOSIS.

3-2. Before beginning diassembly of any unit of the fire detection system, perform the applicable tests described in Section II to determine the condition of the equipment.

3-3. Complete relay panels which are functioning properly in all respects need be disassembled only to the extend of removing sensitive relays, thermal test units and the chassis in order to permit normal overhaul. Thermal test units and sensitive relays can then be individually tested.

3-4. REPAIR OF THERMOCOUPLES AND THERMAL TEST UNITS.

3-5. Thermocouples and thermal test units which are found to be faulty must be replaced since no repairs are recommended.

3-6. OVERHAUL AND REPAIR OF SENSITIVE RELAYS.

3-7. It is recommended that faulty sensitive relays be returned to the factory for repairs. Such work should be attempted in the field only if a well equipped instrument repair shop staffed by trained instrument mechanics is available. For specific instructions as to procedure, refer to Edison Publication No. 1025. Sensitive relays which are functioning properly require no overhaul.

3-8. DISASSEMBLY OF RELAY PANELS.

3-9. Procedure is quite apparent. In the case of multi-circuit panels, thermal test units and sensitive relays must be removed before attempting to remove chassis from case. Removal of the eight receptacle mounting screws will permit the receptacles to be pushed into the case as the chassis is tipped to a position to allow it to be withdrawn.

3-10. CLEANING, INSPECTION, TESTING, AND REPAIR OF RELAY PANELS.

a. Blow accumulated dust from chassis and case.

b. If case is provided with shock mounts, inspect condition of rubber and replace mount if necessary.

c. Check all wiring for loose connections and misplaced wires or worn insulation which might cause short circuits.

d. Check condition of receptacle pins and of test unit and sensitive relay sockets. Replace parts if defective.

e. Disconnect resistors and check their resistances with values shown on applicable panel wiring diagram. Replace defective resistors.

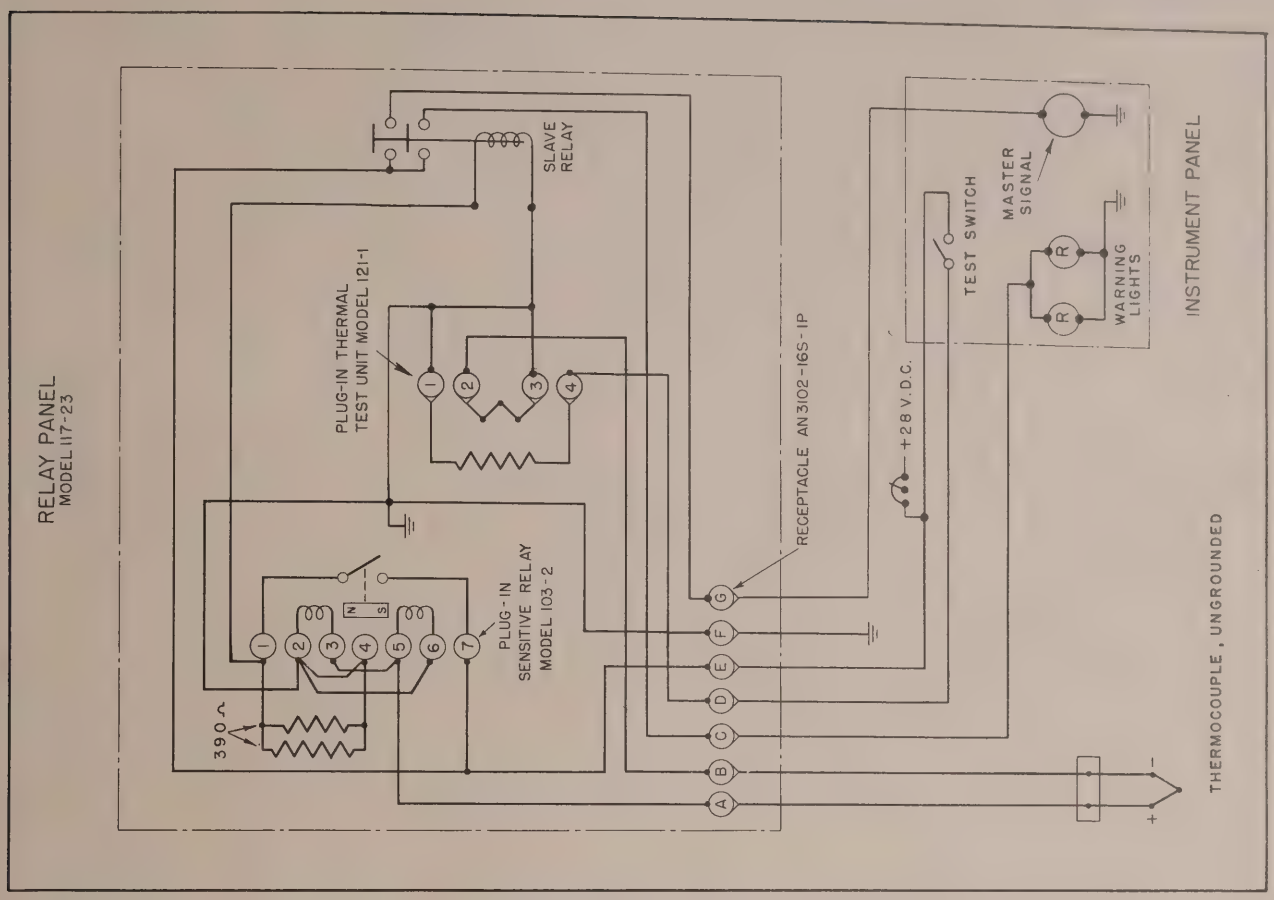
f. Inspect and clean slave relay contacts. Test relay operation by energizing their windings directly, using the proper voltage. Replace defective relays.

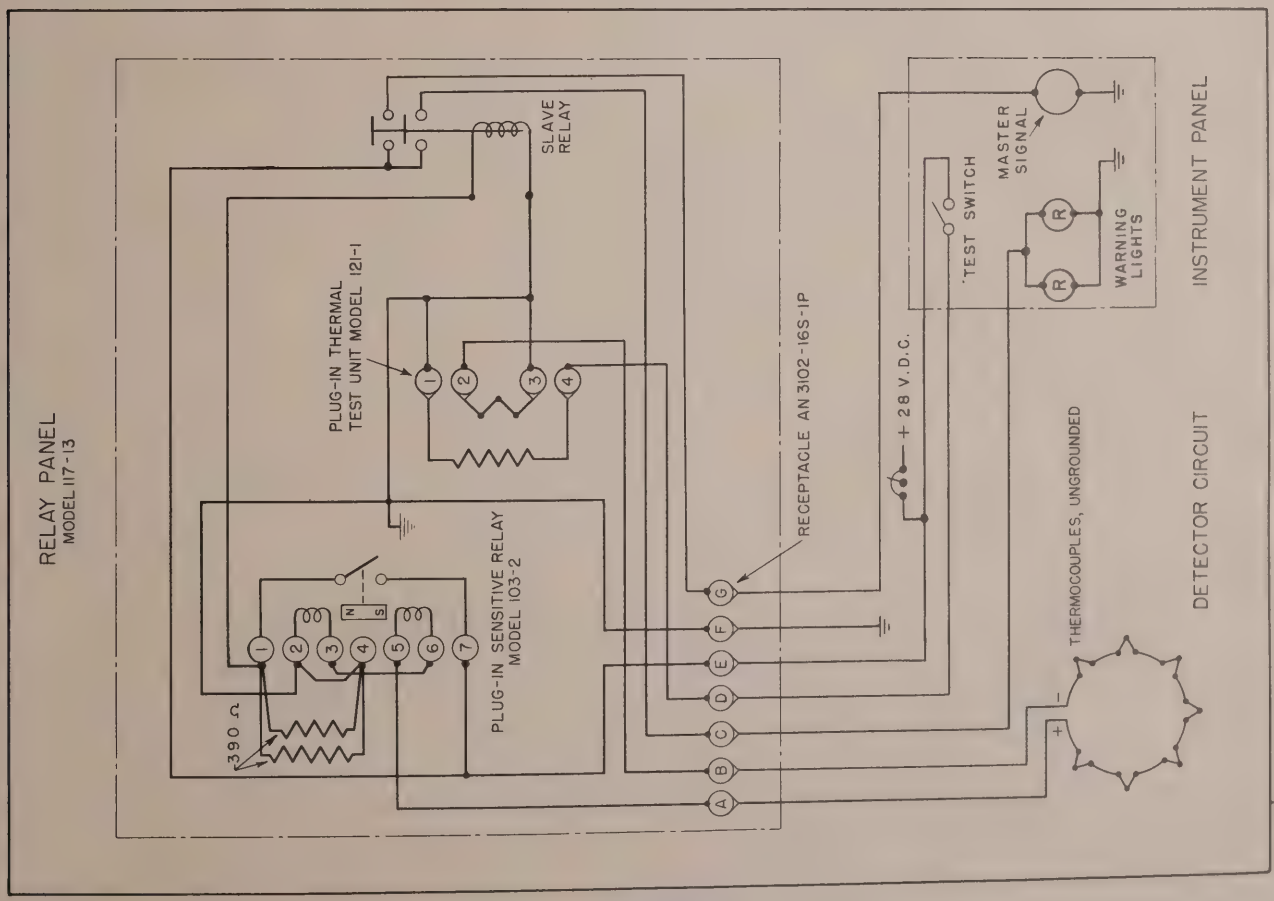
3-11. REASSEMBLY.

a. In rewiring chassis, follow applicable panel wiring diagram.

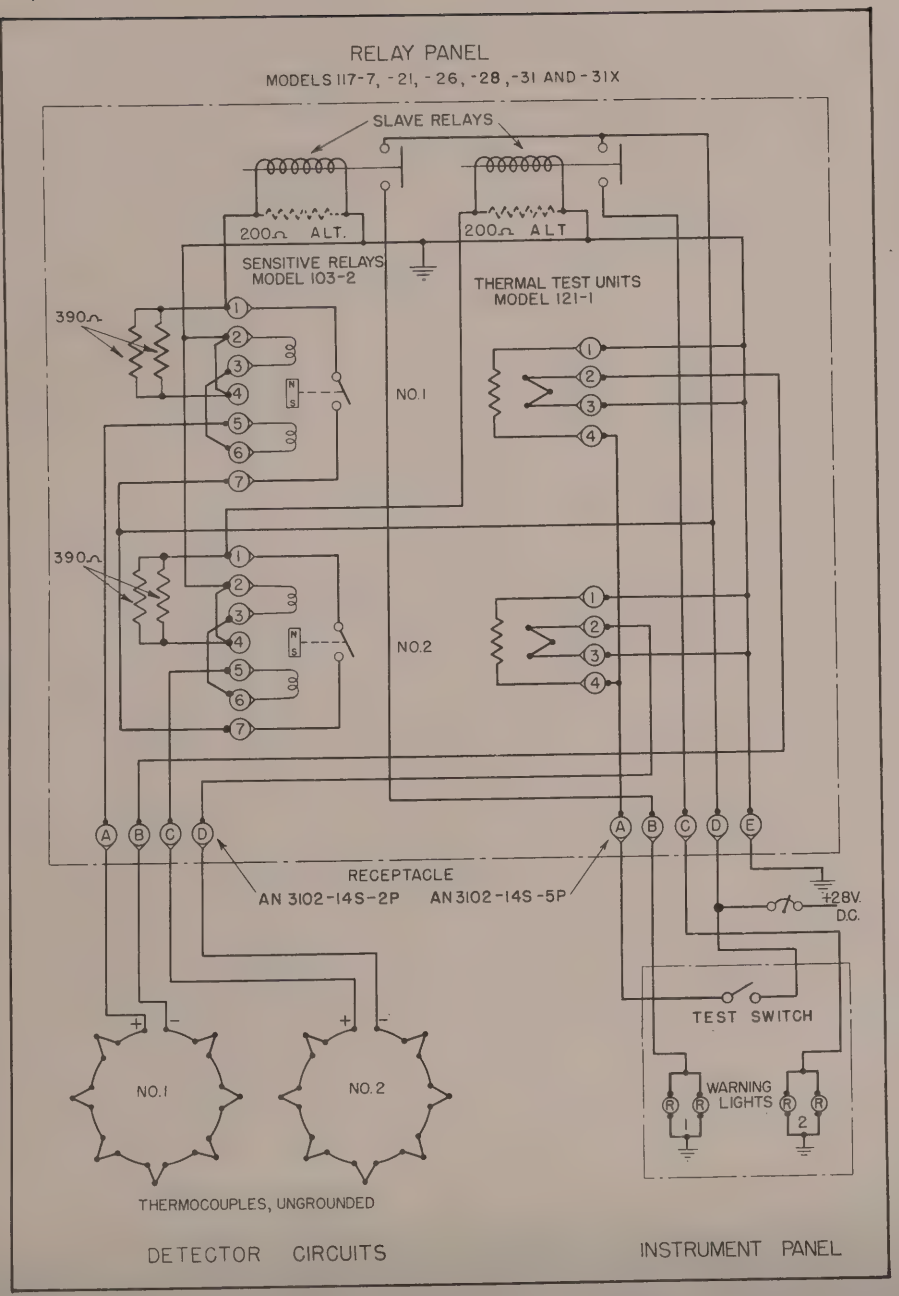
b. Reassembly procedure is obvious.

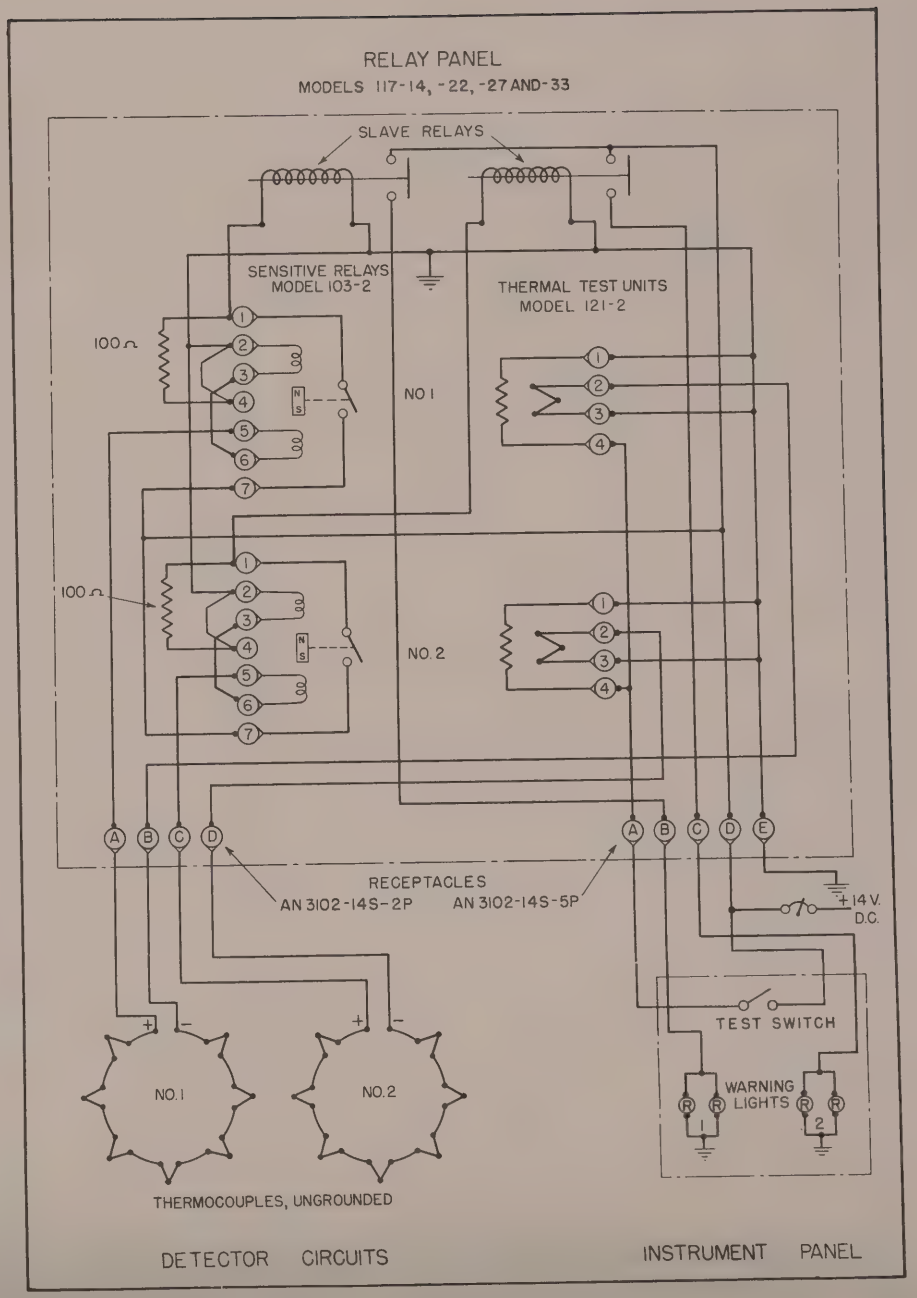
c. After thermal test units and sensitive relays have been installed, test the panels as directed in paragraph 2-15 a.



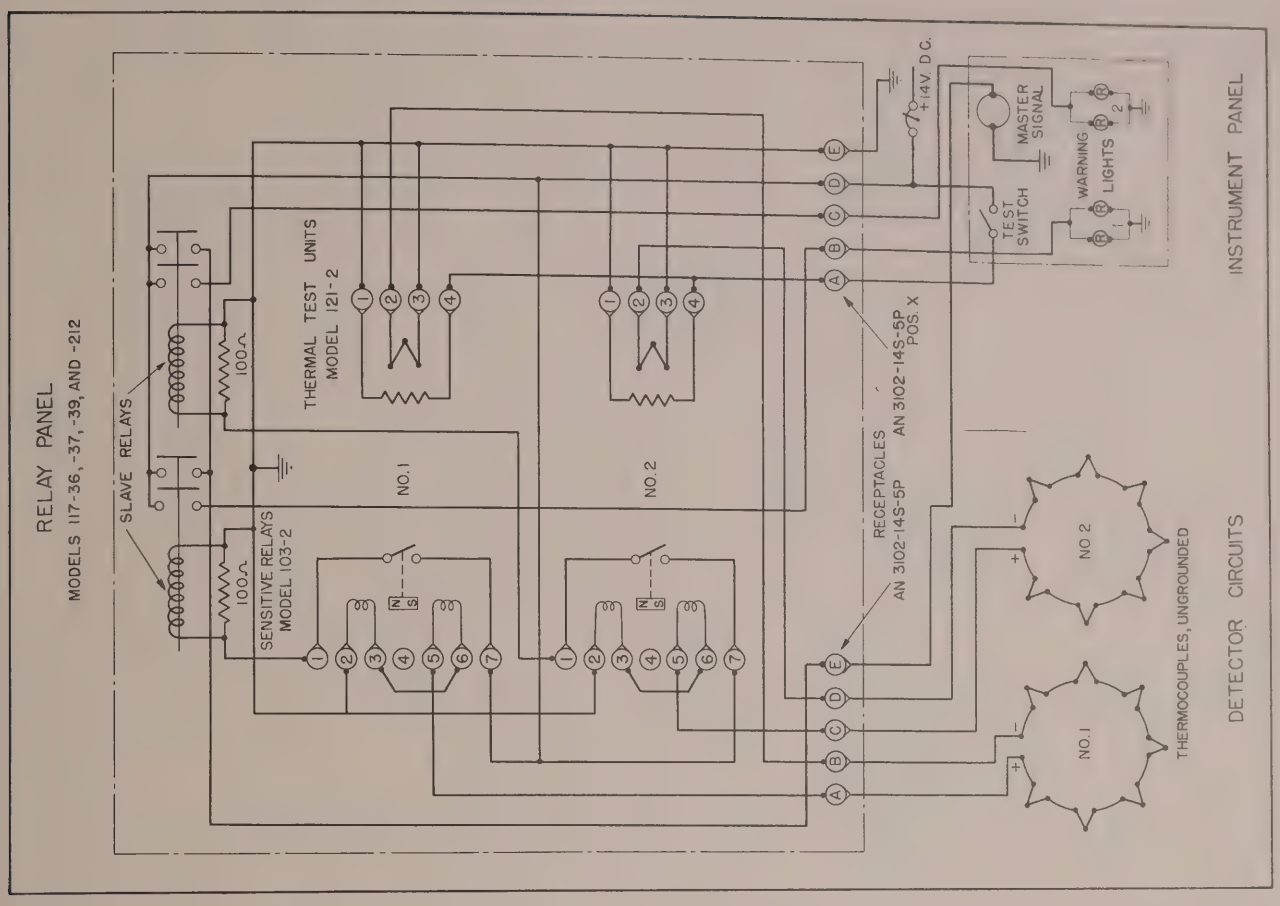


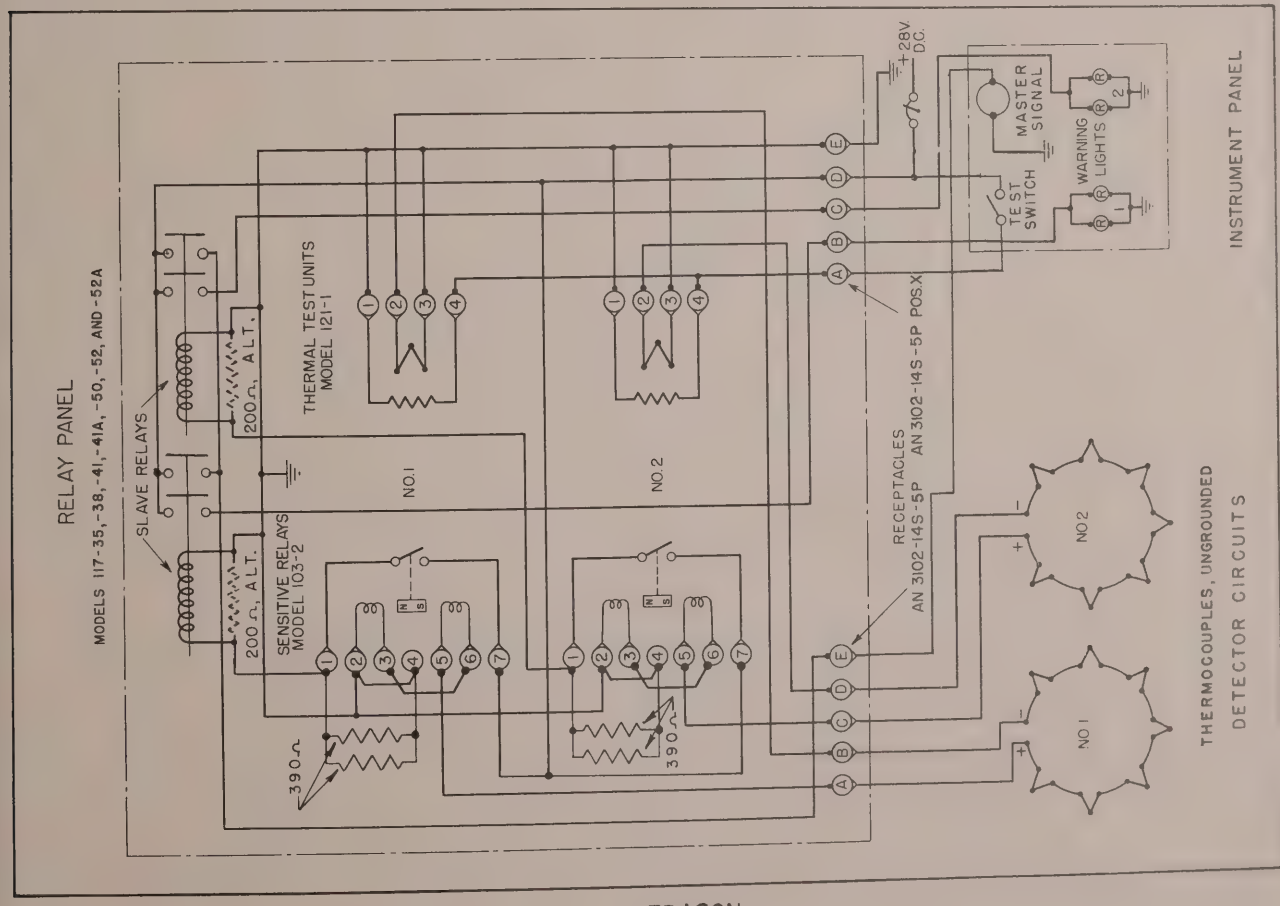
Schematic Wiring Diagram - One Circuit Panels



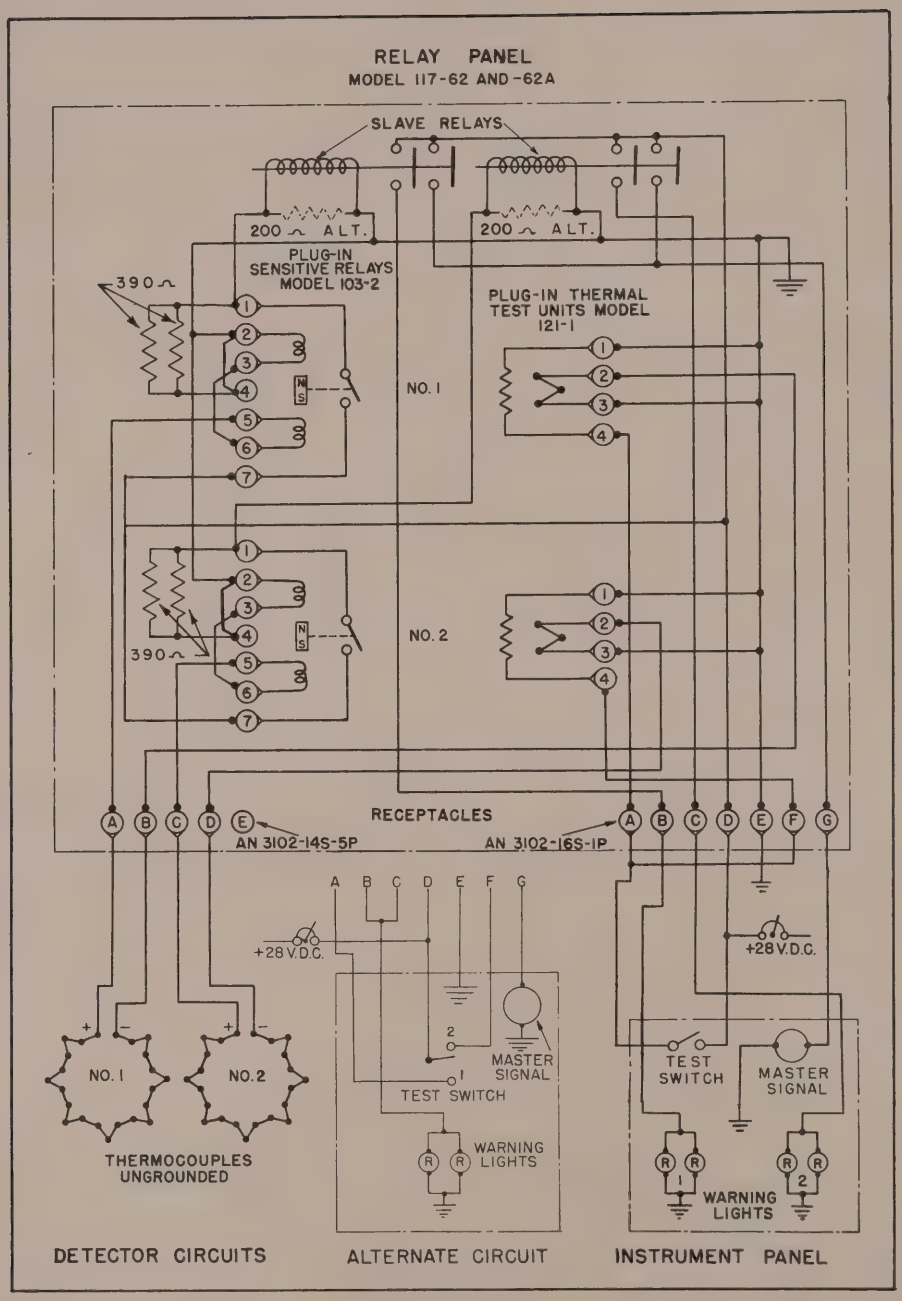


Schematic Wiring Diagram - Two Circuit Panels

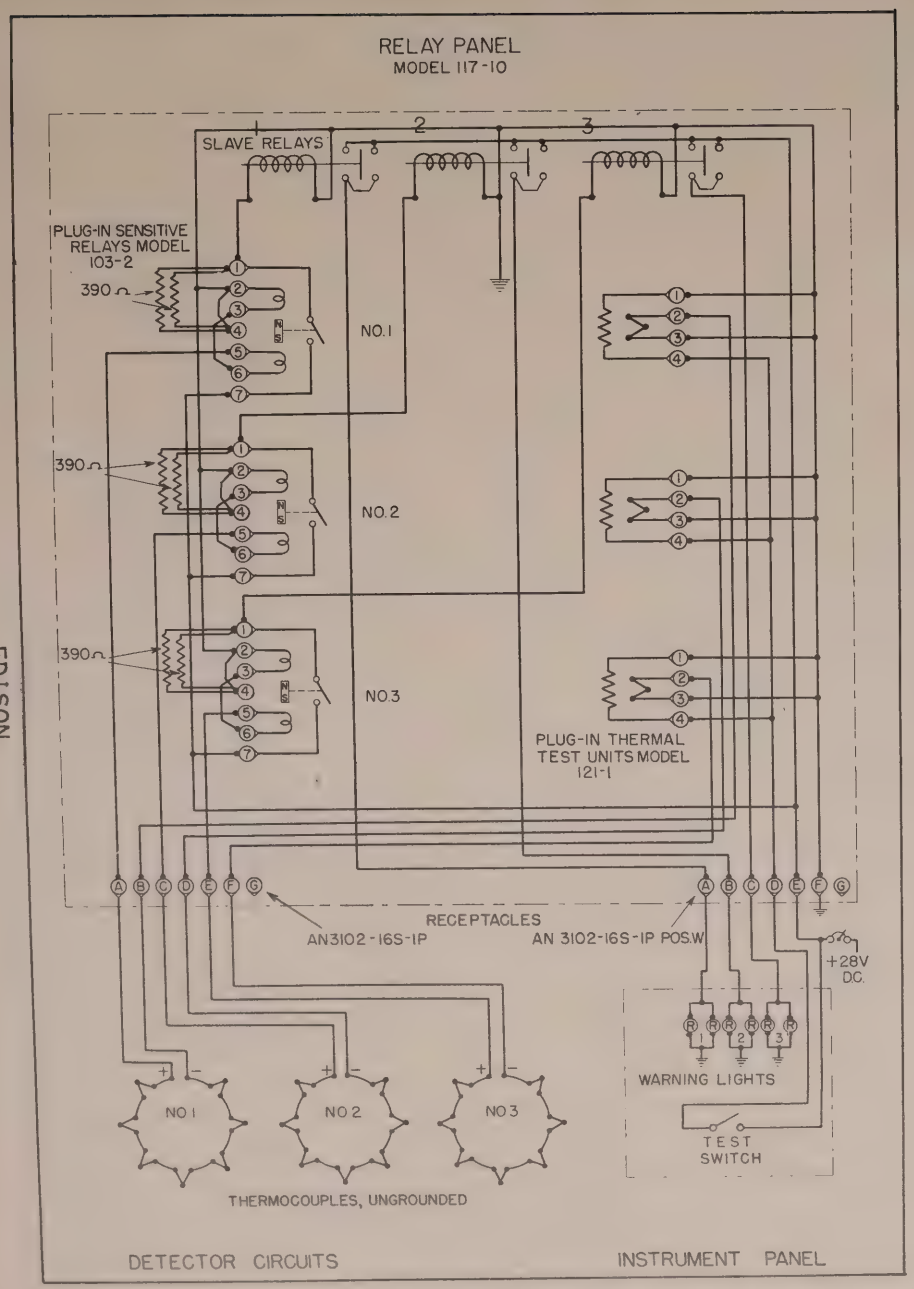


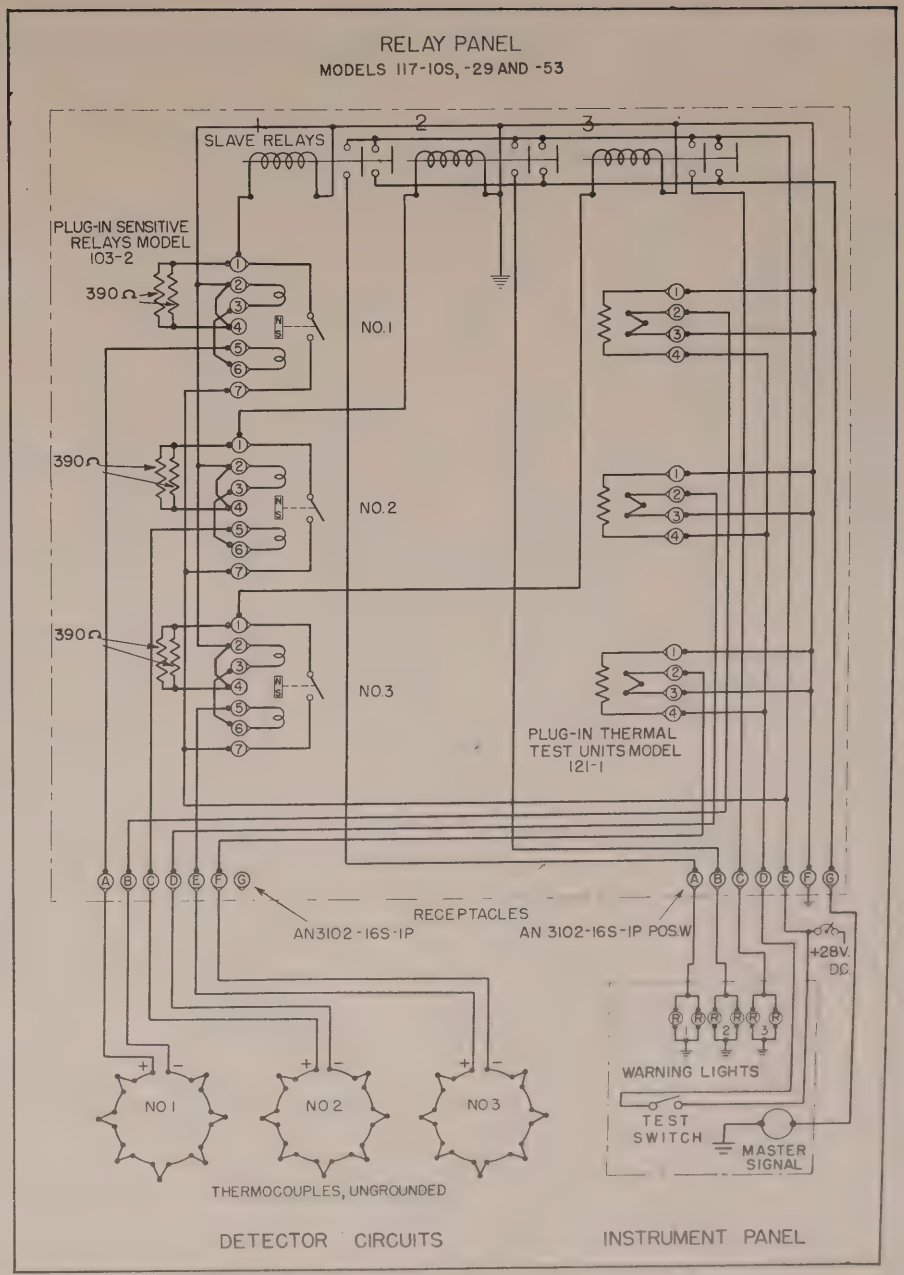


Schematic Wiring Diagram - Two Circuit Panels - continued

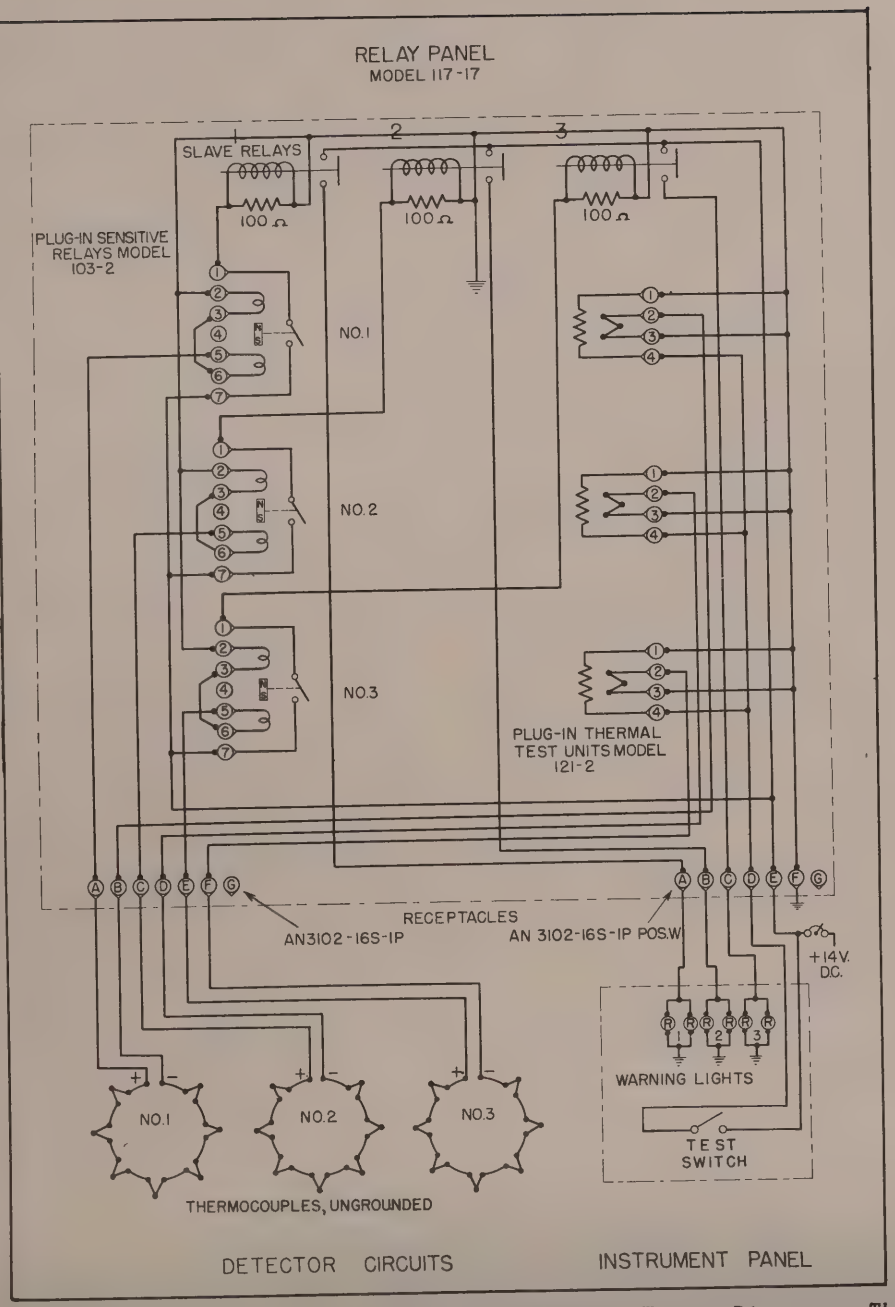


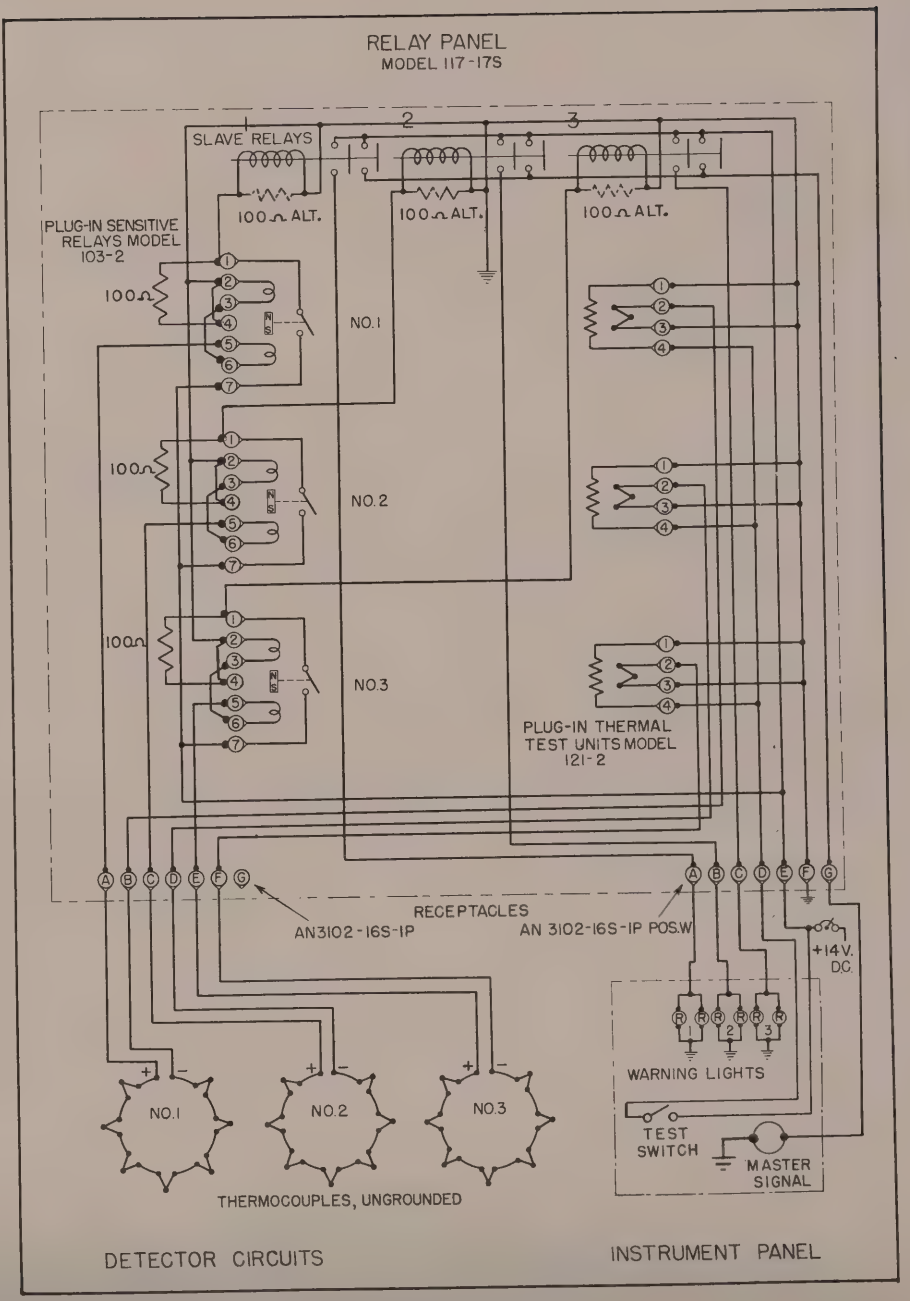
Schematic Wiring Diagram - Two Circuit Panels - continued



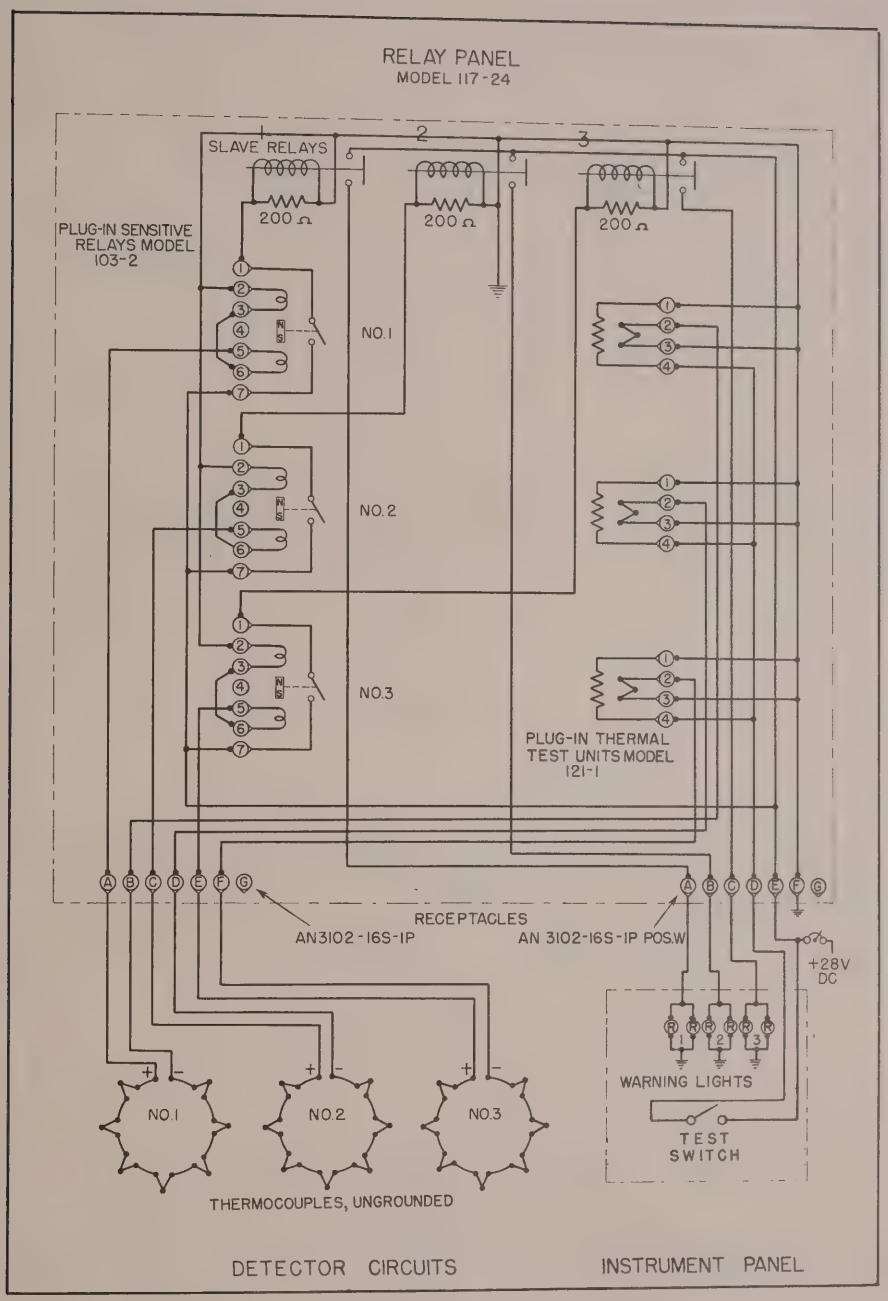


Schematic Wiring Diagram - Three Circuit Panels

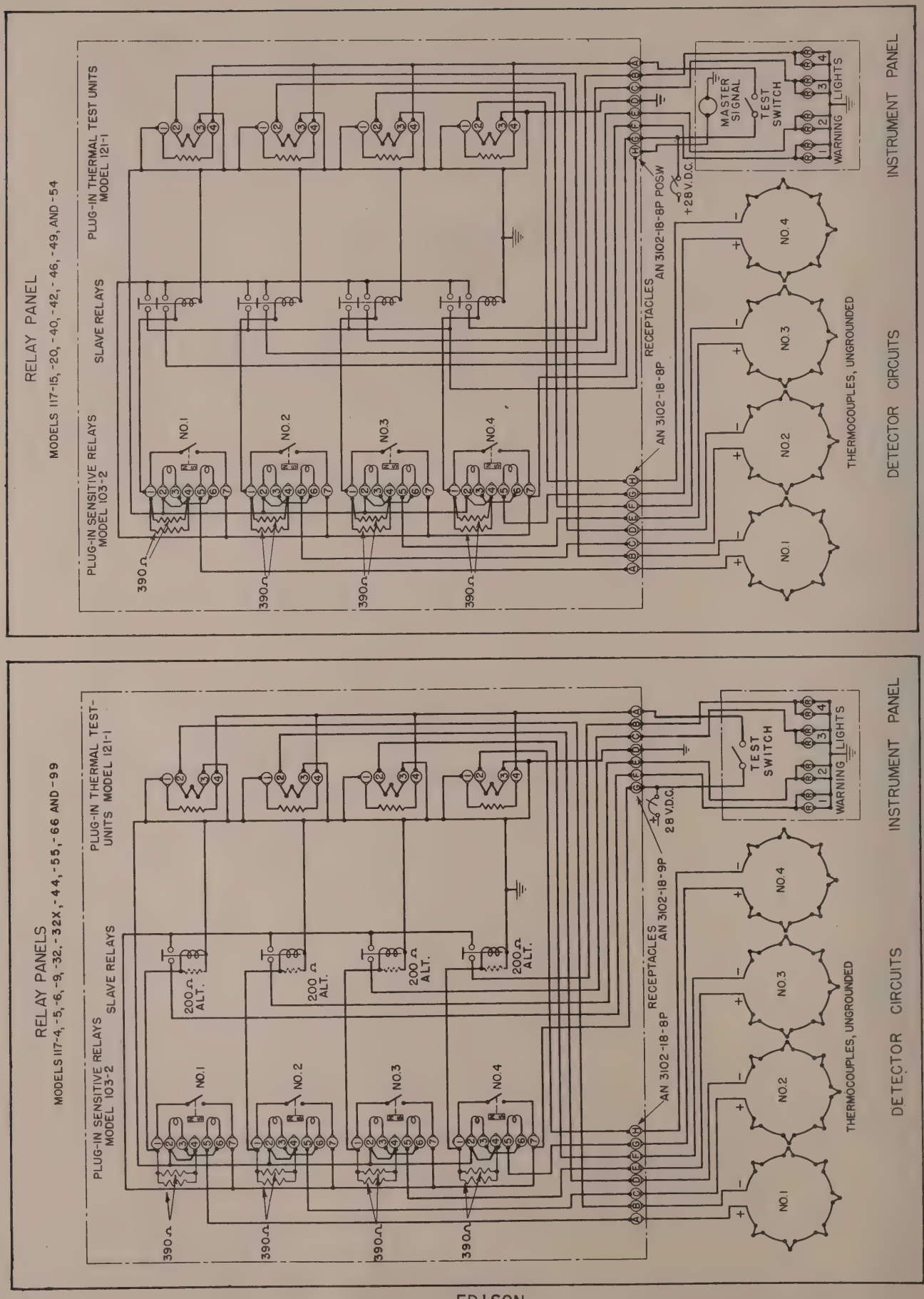




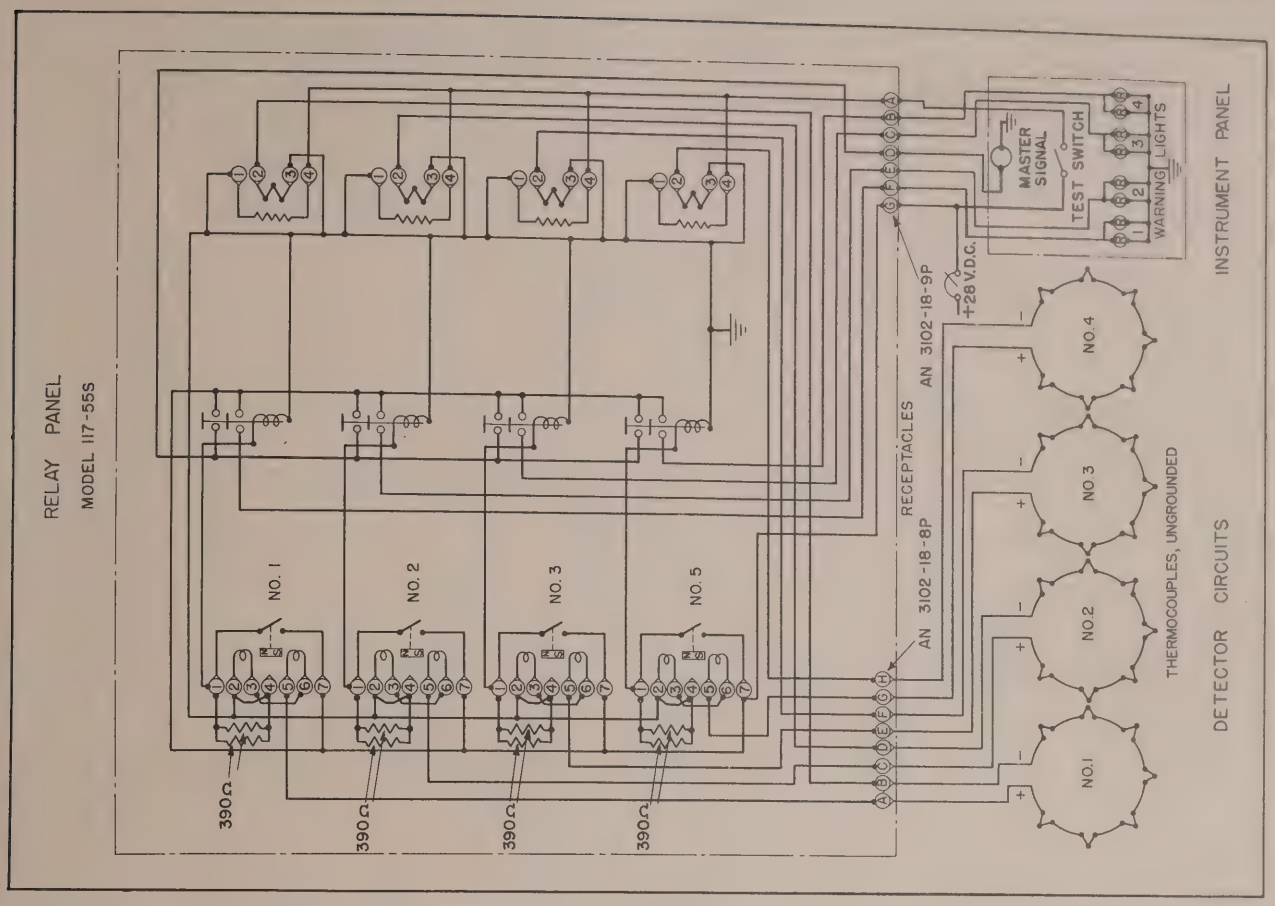
Schematic Wiring Diagram - Three Circuit Panels - continued

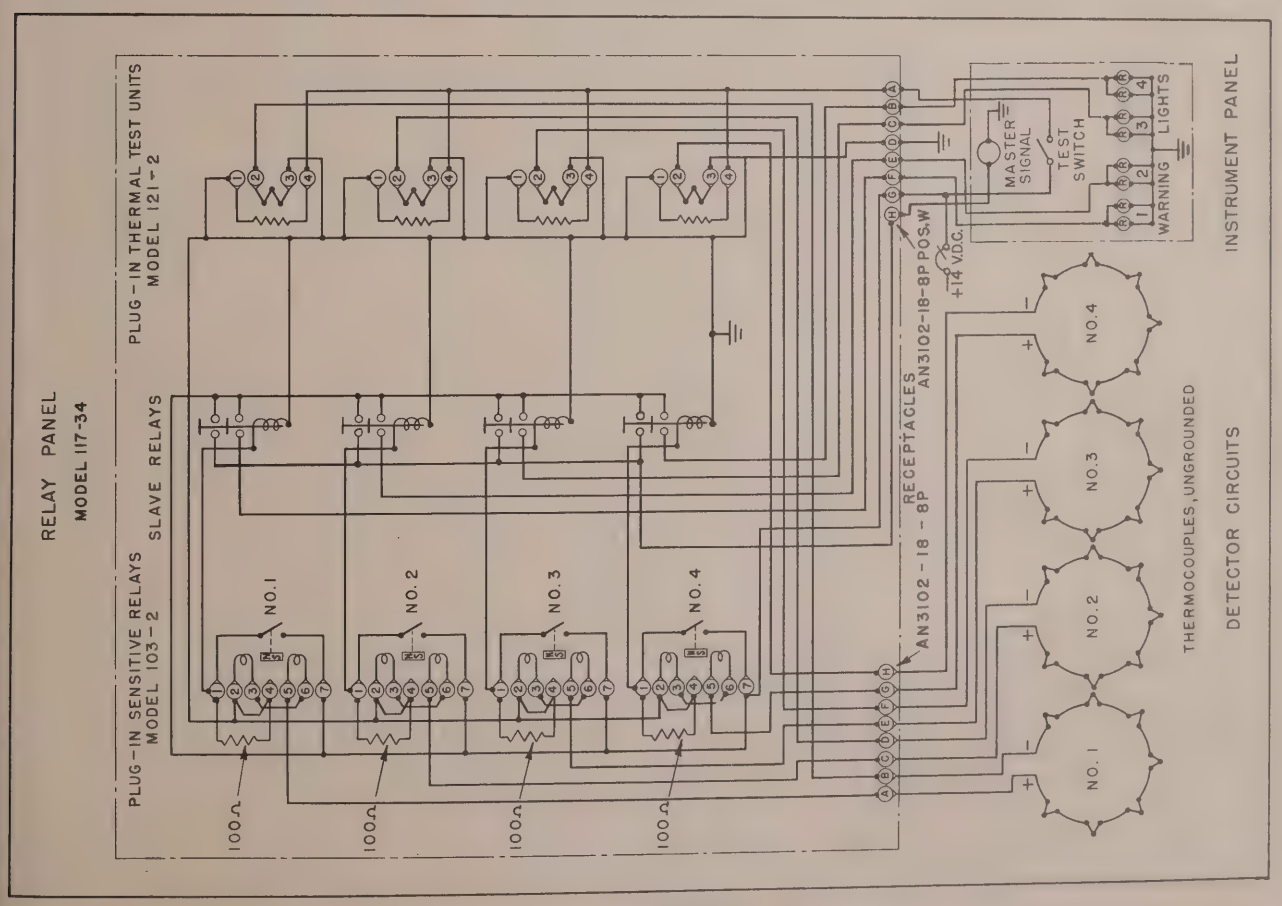


Schematic Wiring Diagram - Three Circuit Panels - continued

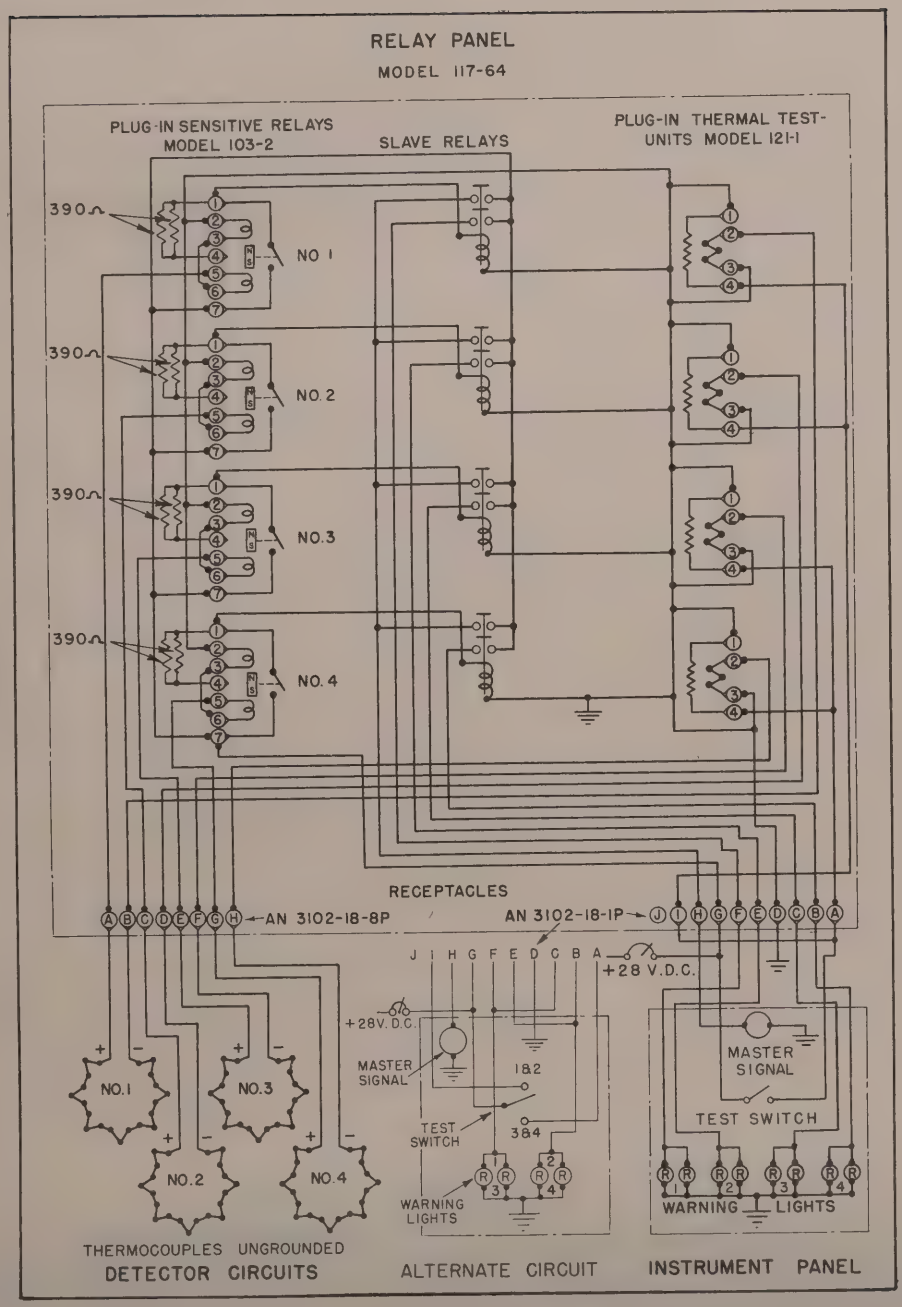


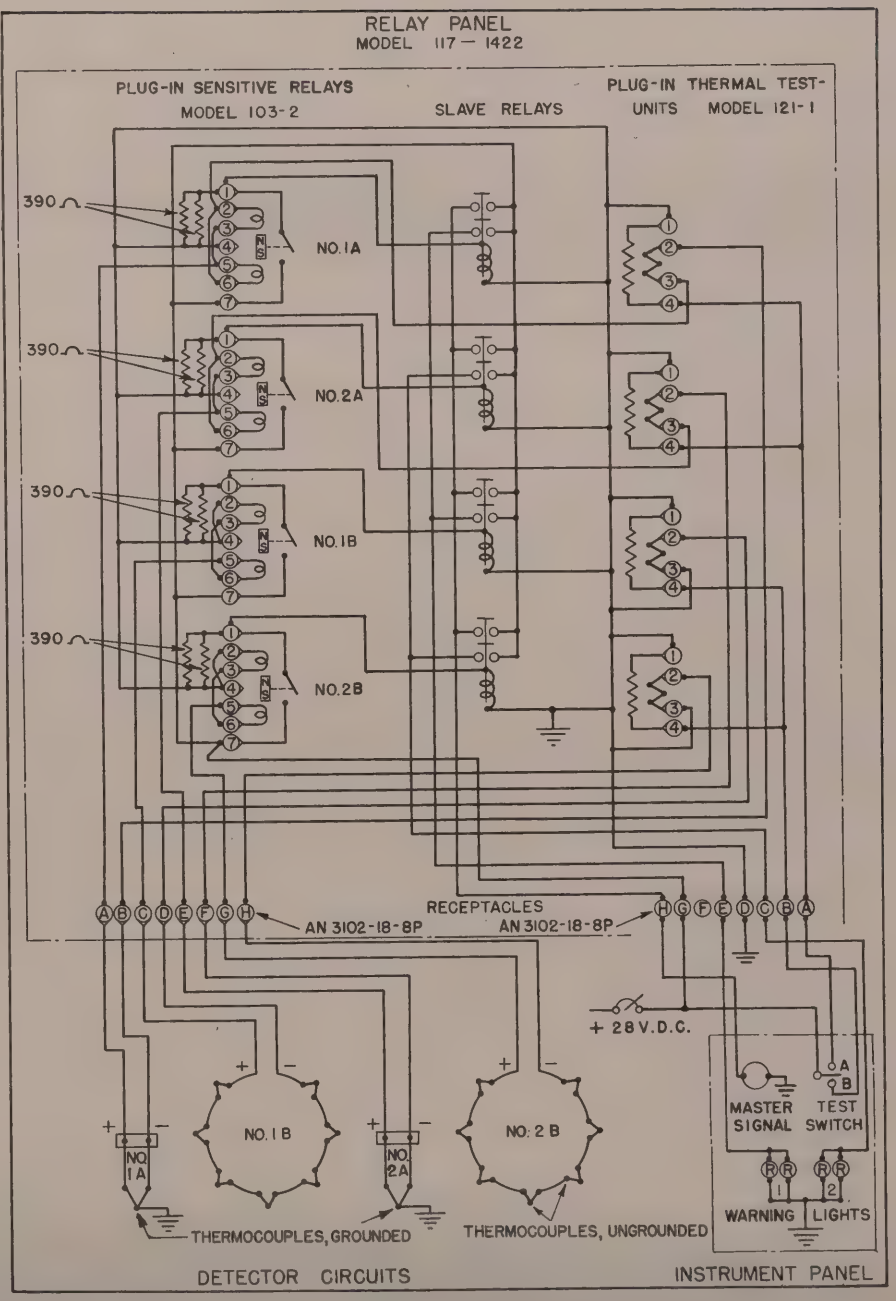
Schematic Wiring Diagram - Four Circuit Panels



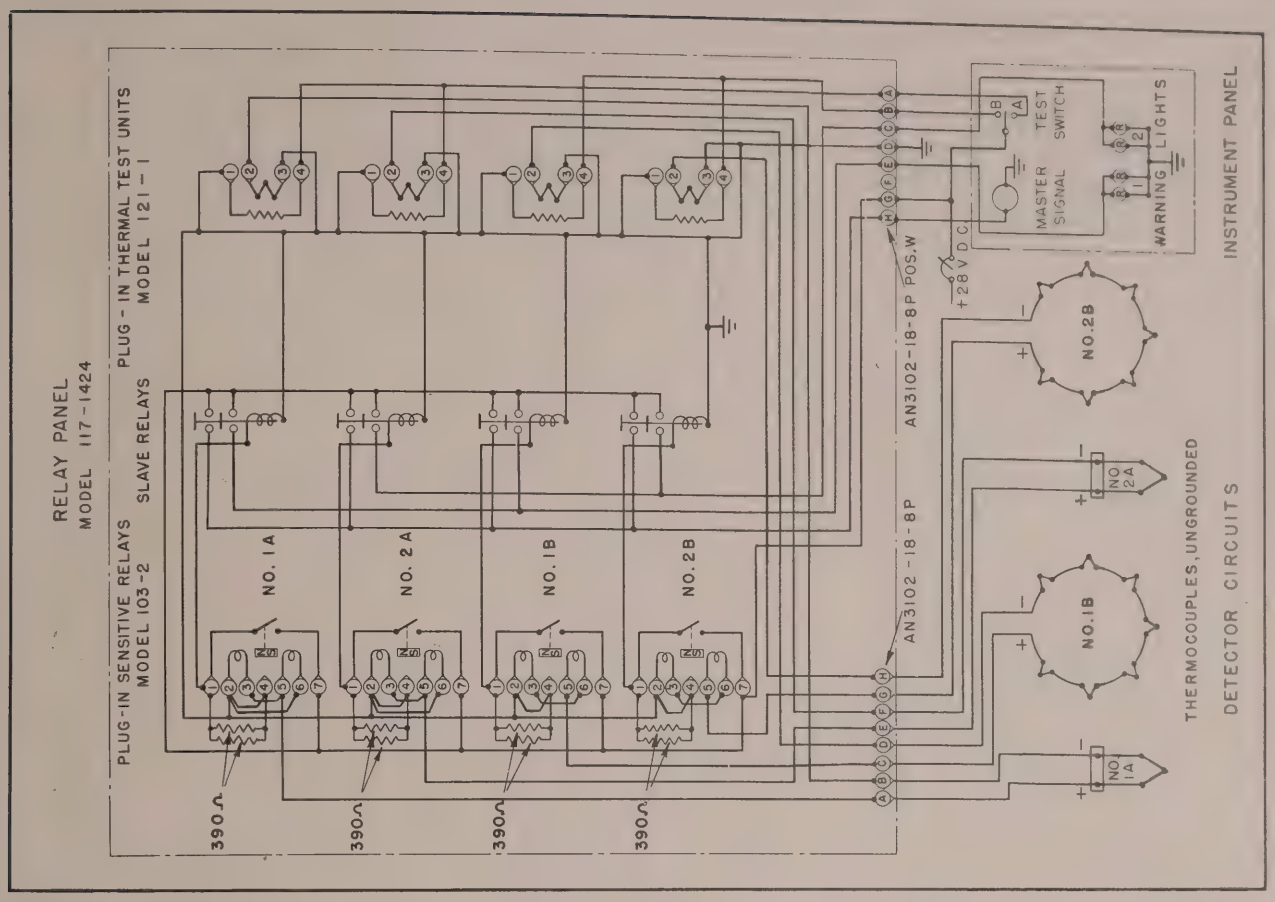


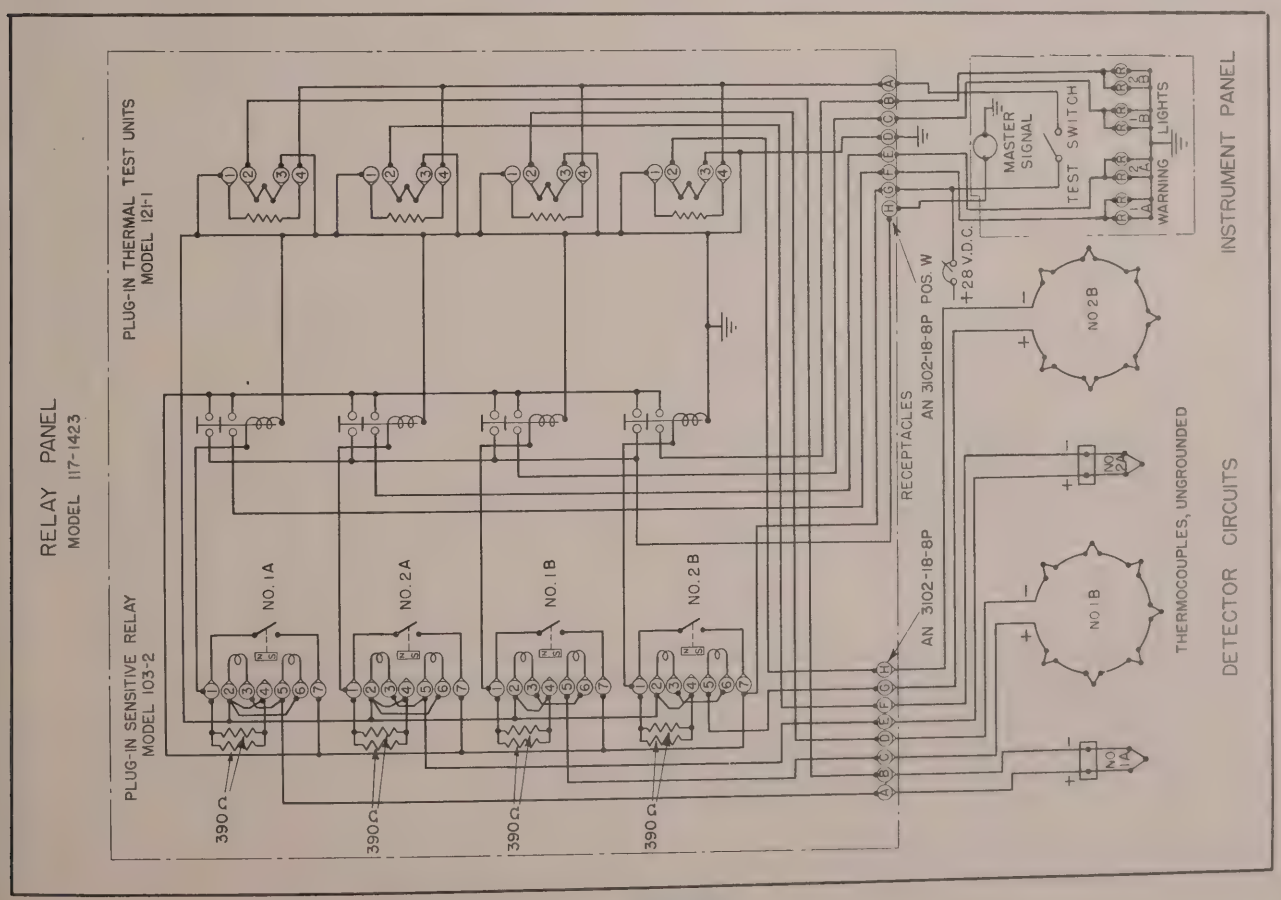
Schematic Wiring Diagram - Four Circuit Panels - continued



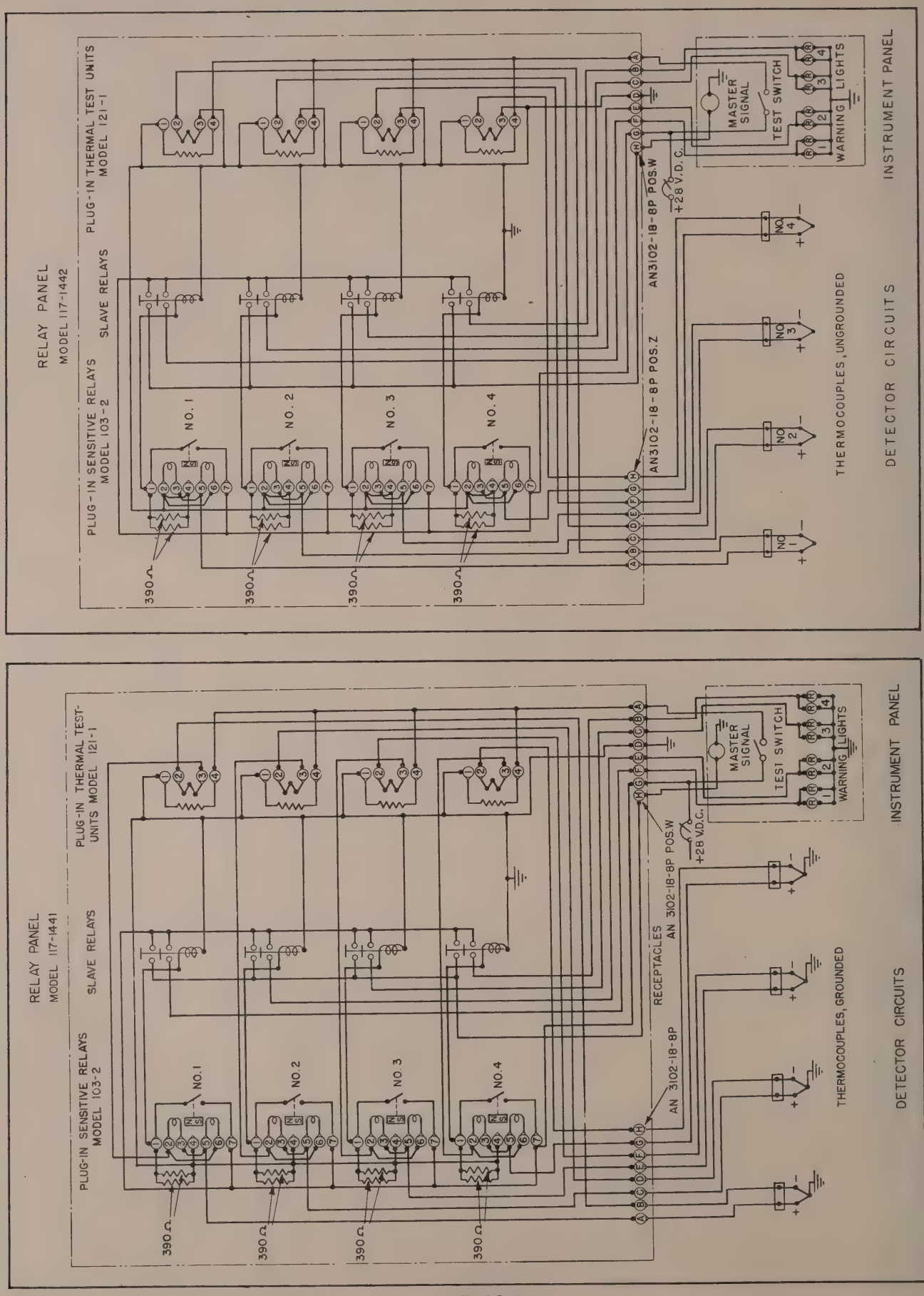


Schematic Wiring Diagram - Four Circuit Panels - continued

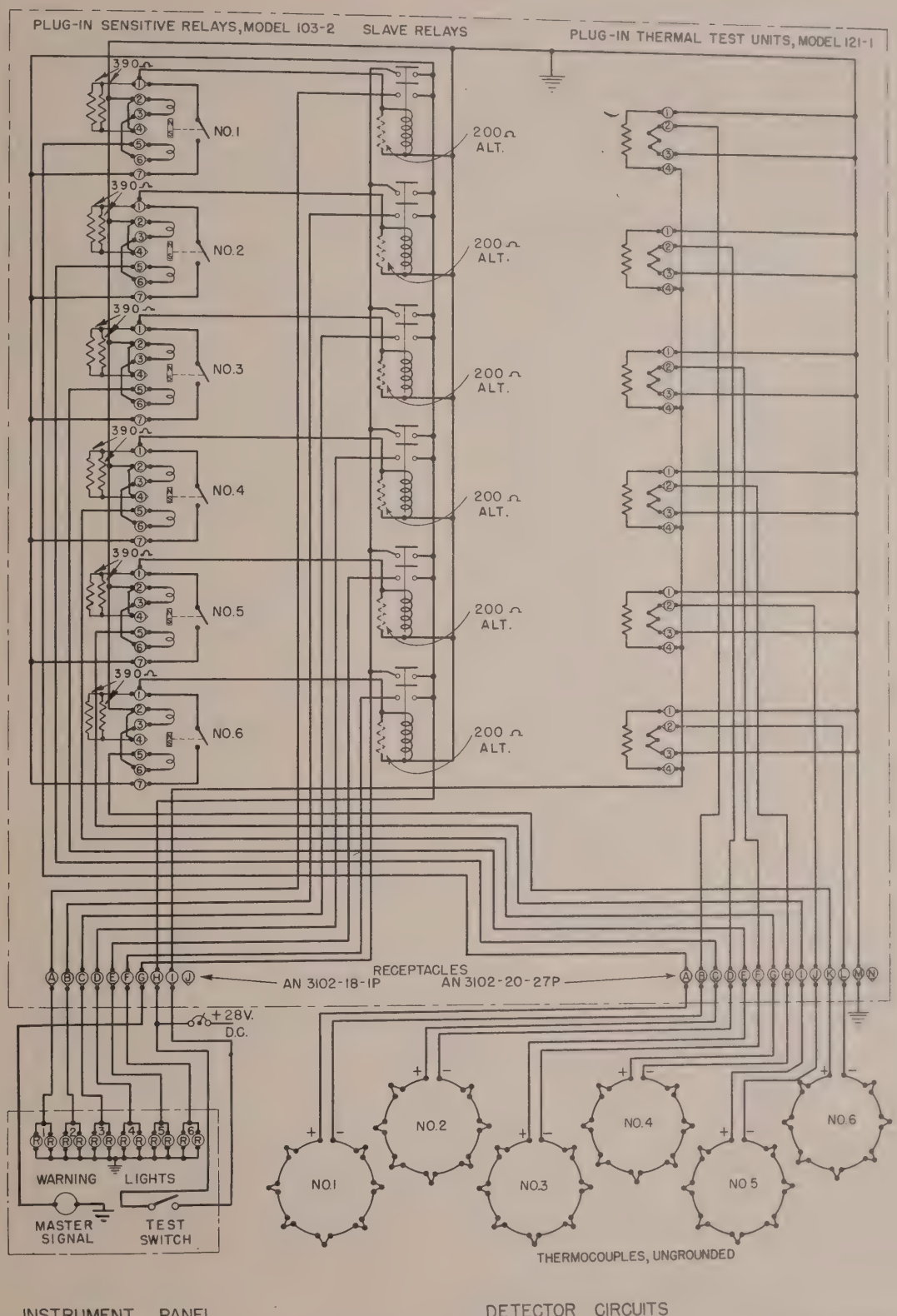




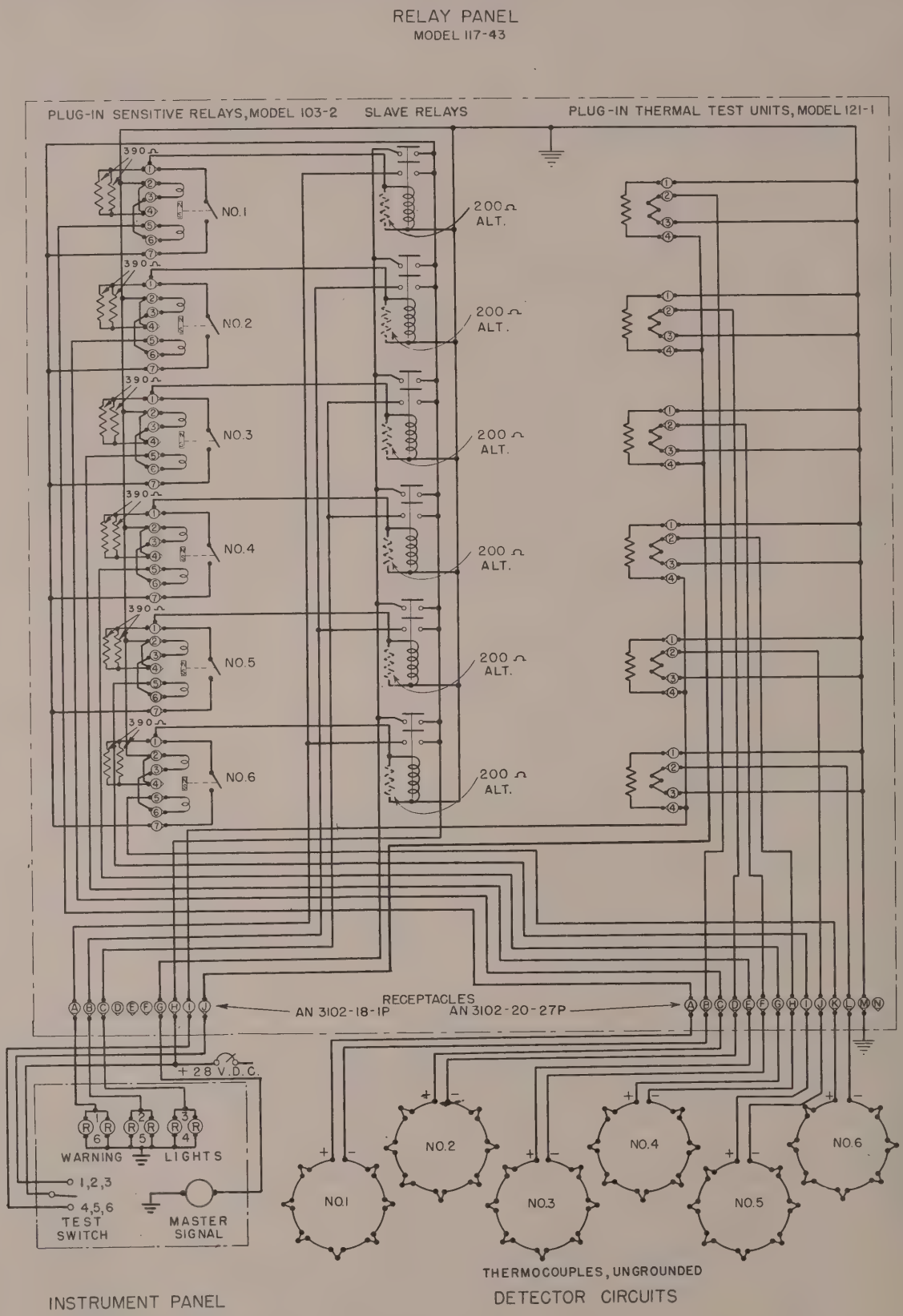
Schematic Wiring Diagram - Four Circuit Panels - continued



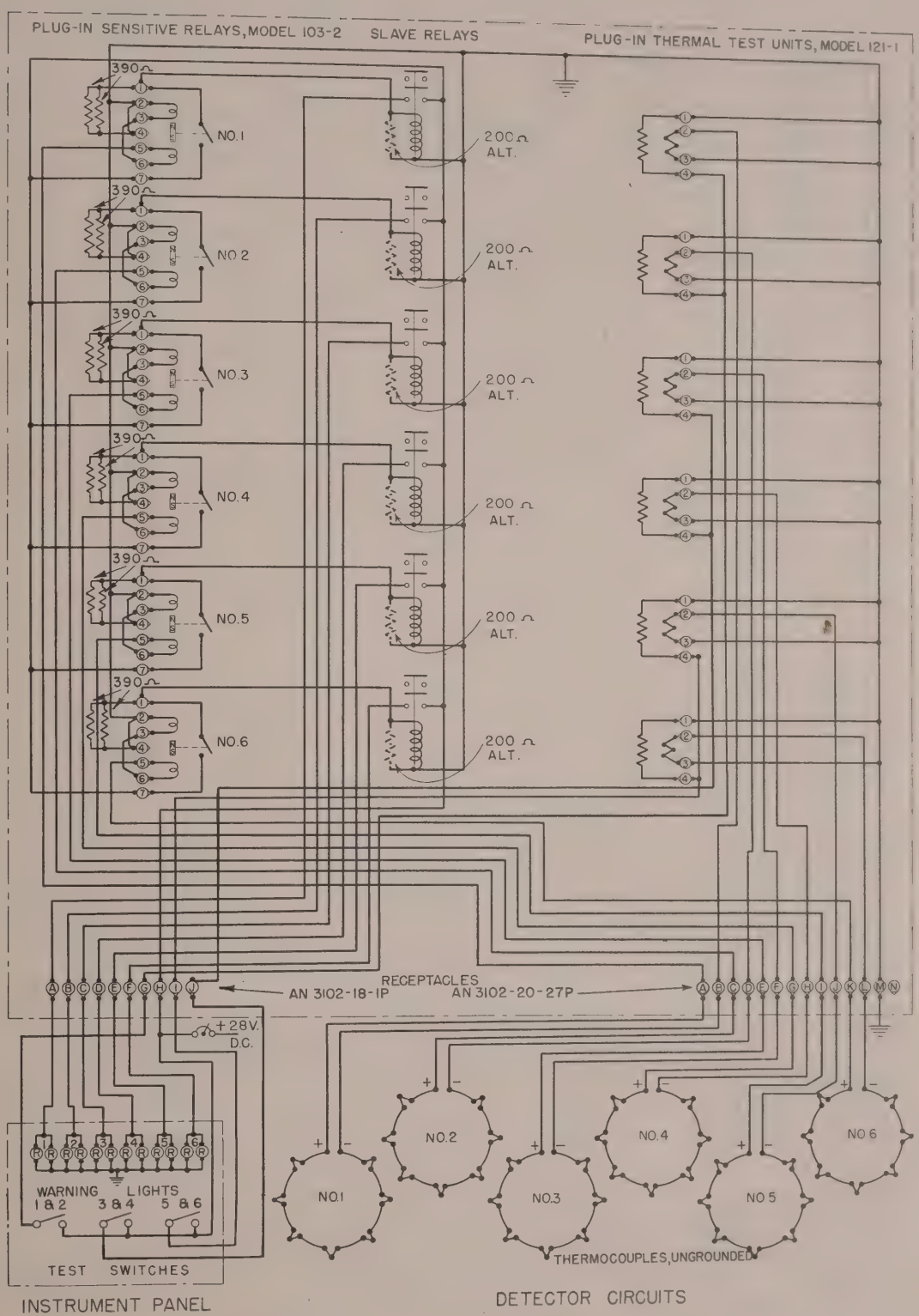
Schematic Wiring Diagram - Four Circuit Panels - continued



Schematic Wiring Diagram - Six Circuit Panels
EDISON

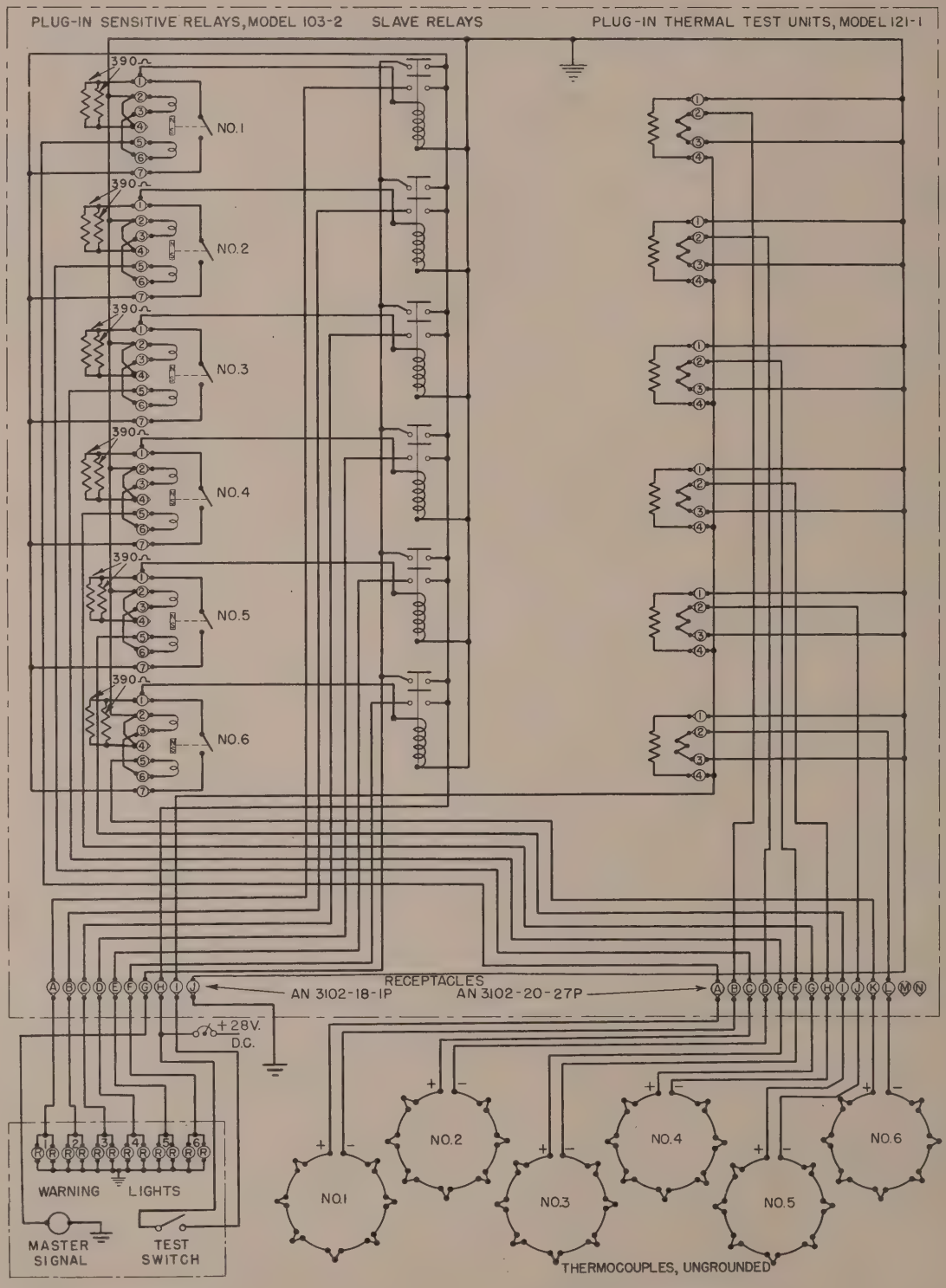


Schematic Wiring Diagram - Six Circuit Panels - continued

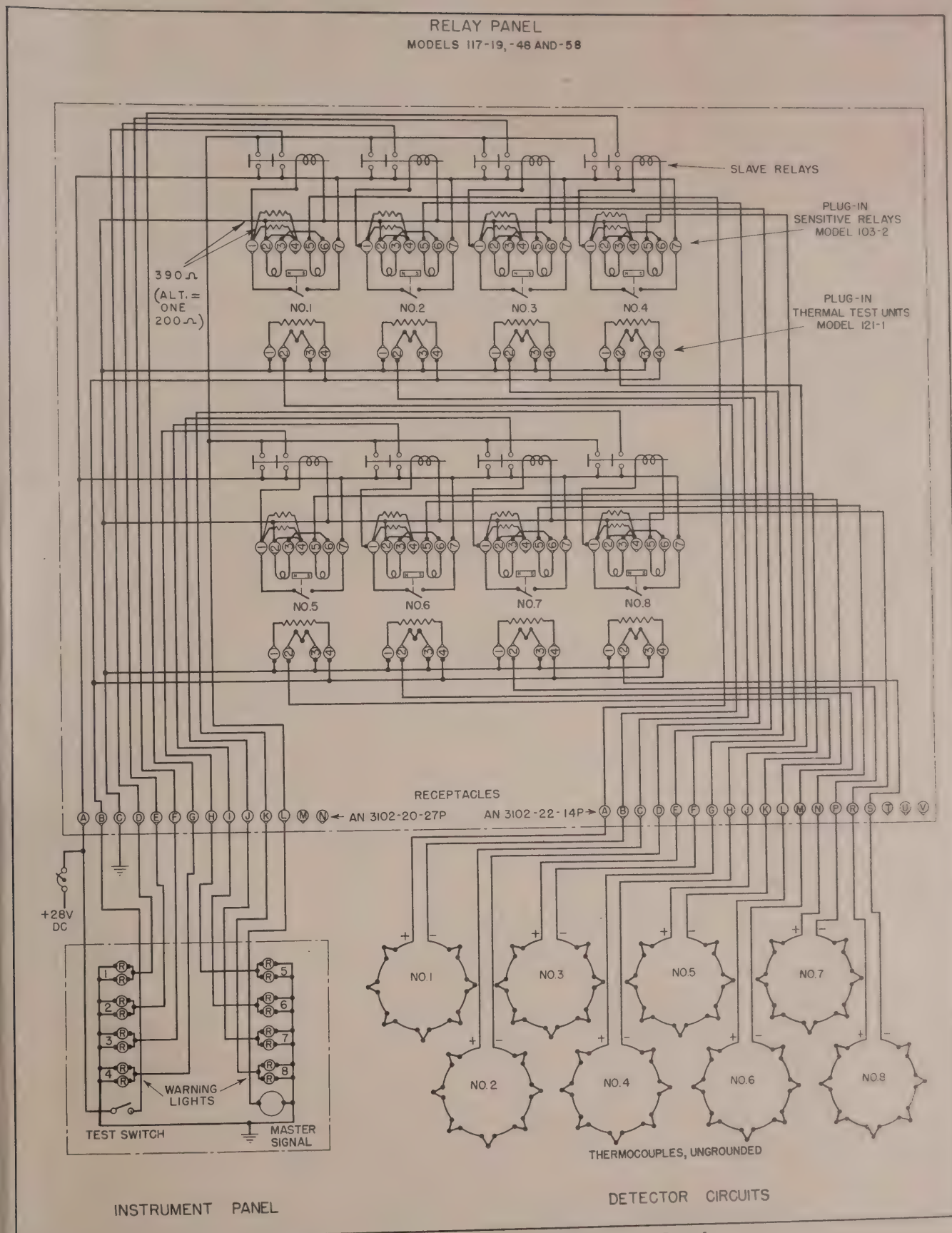


Schematic Wiring Diagram - Six Circuit Panels - continued

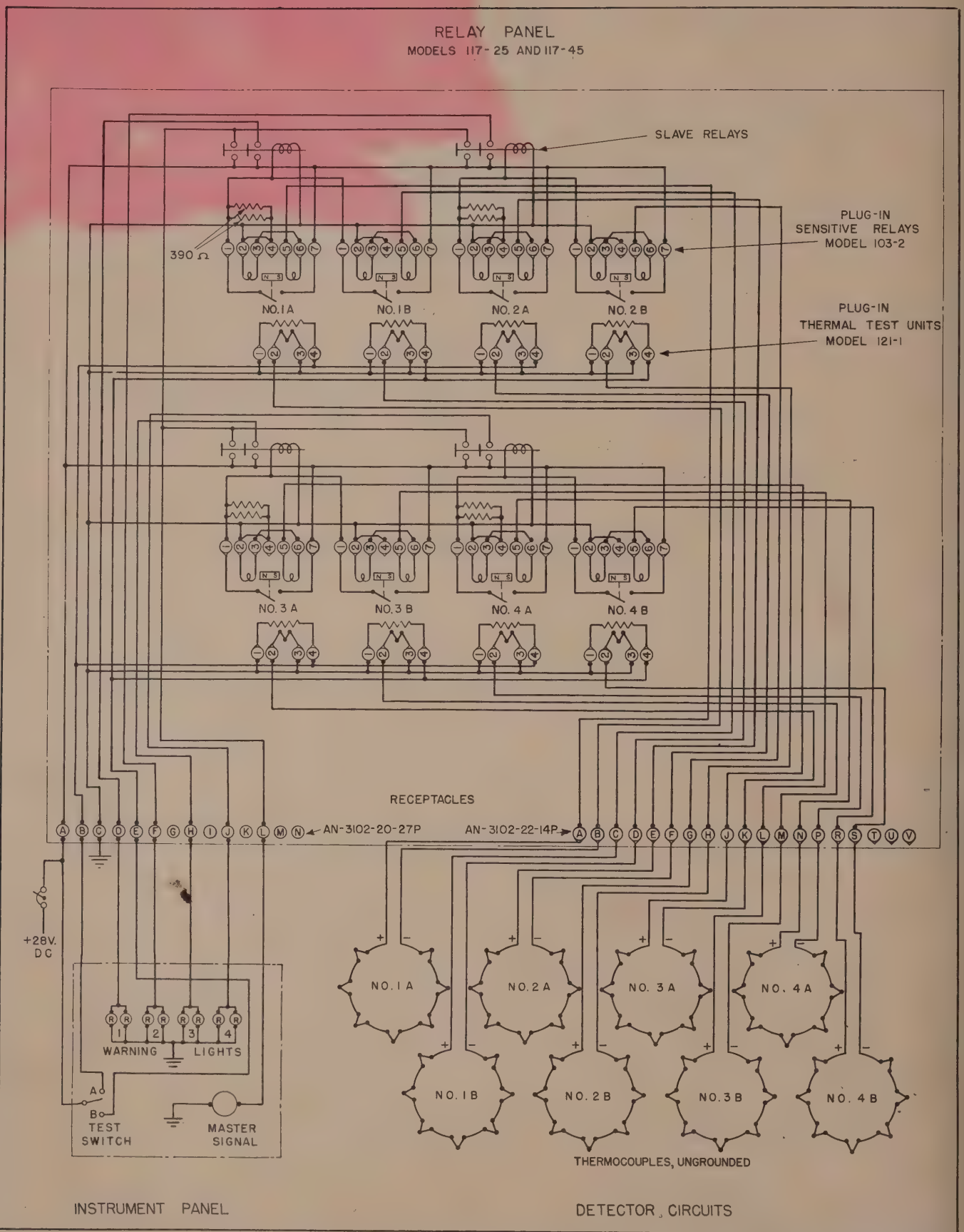
RELAY PANEL
MODEL 117-56



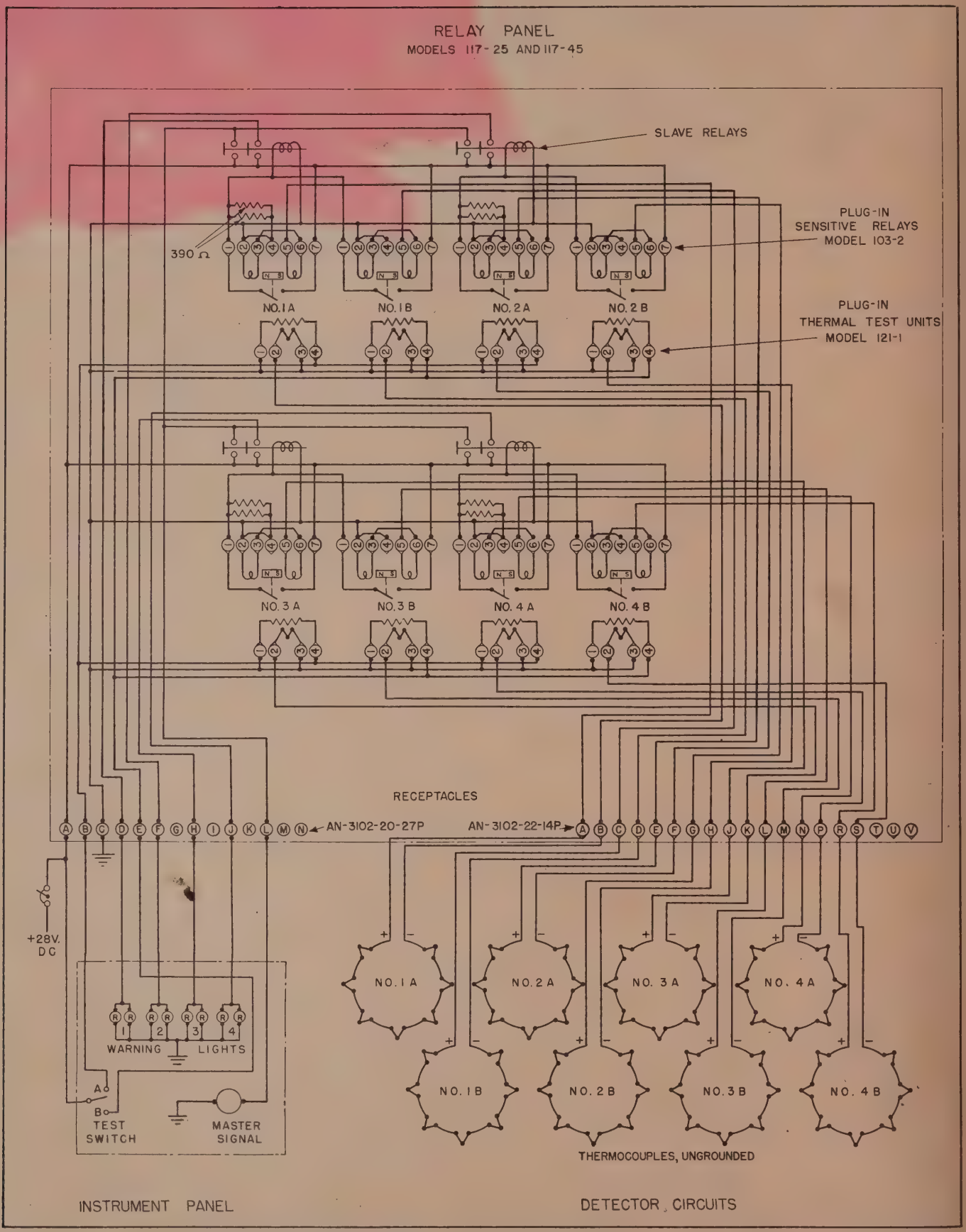
Schematic Wiring Diagram - Six Circuit Panels - continued



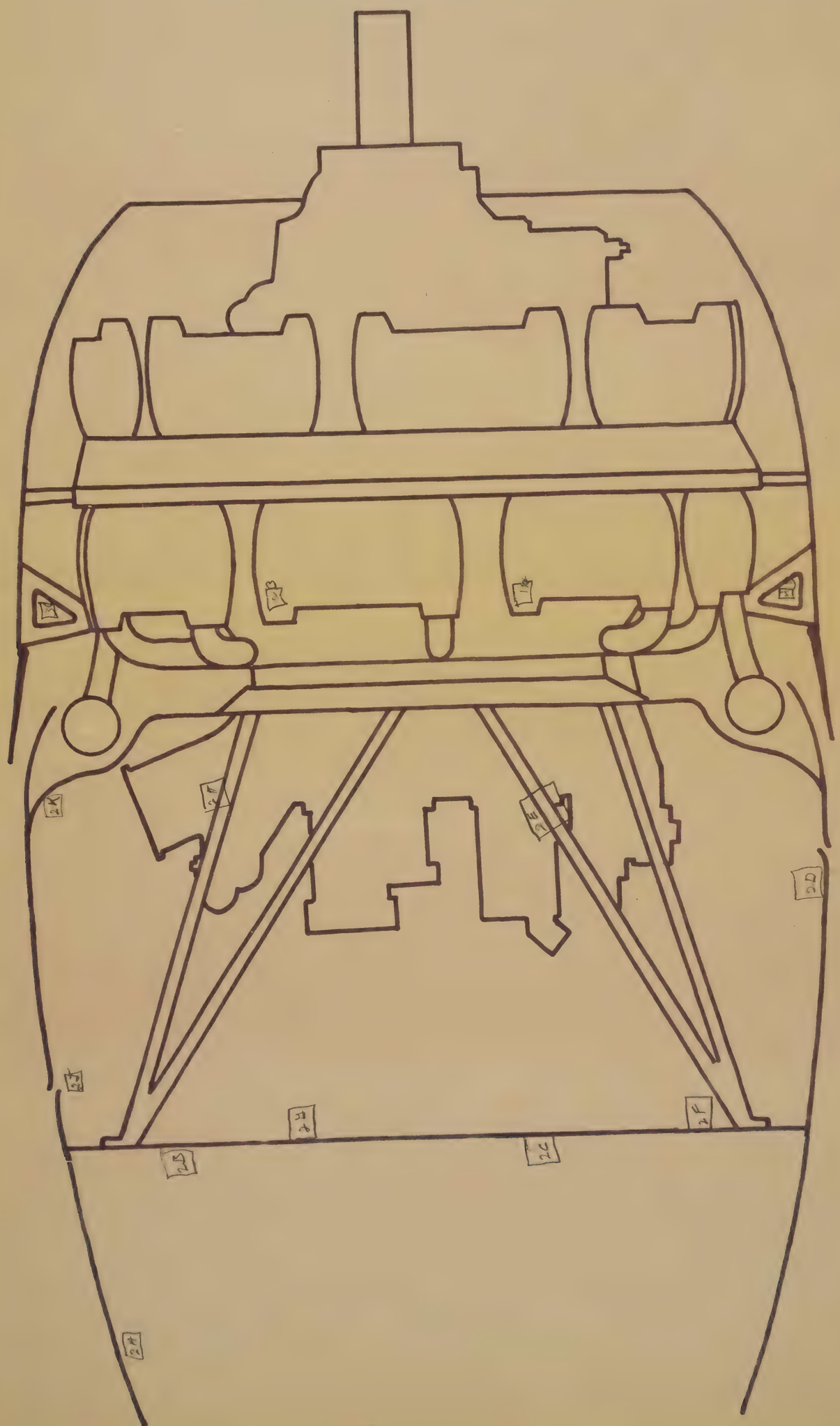
Schematic Wiring Diagram - Eight Circuit Panels

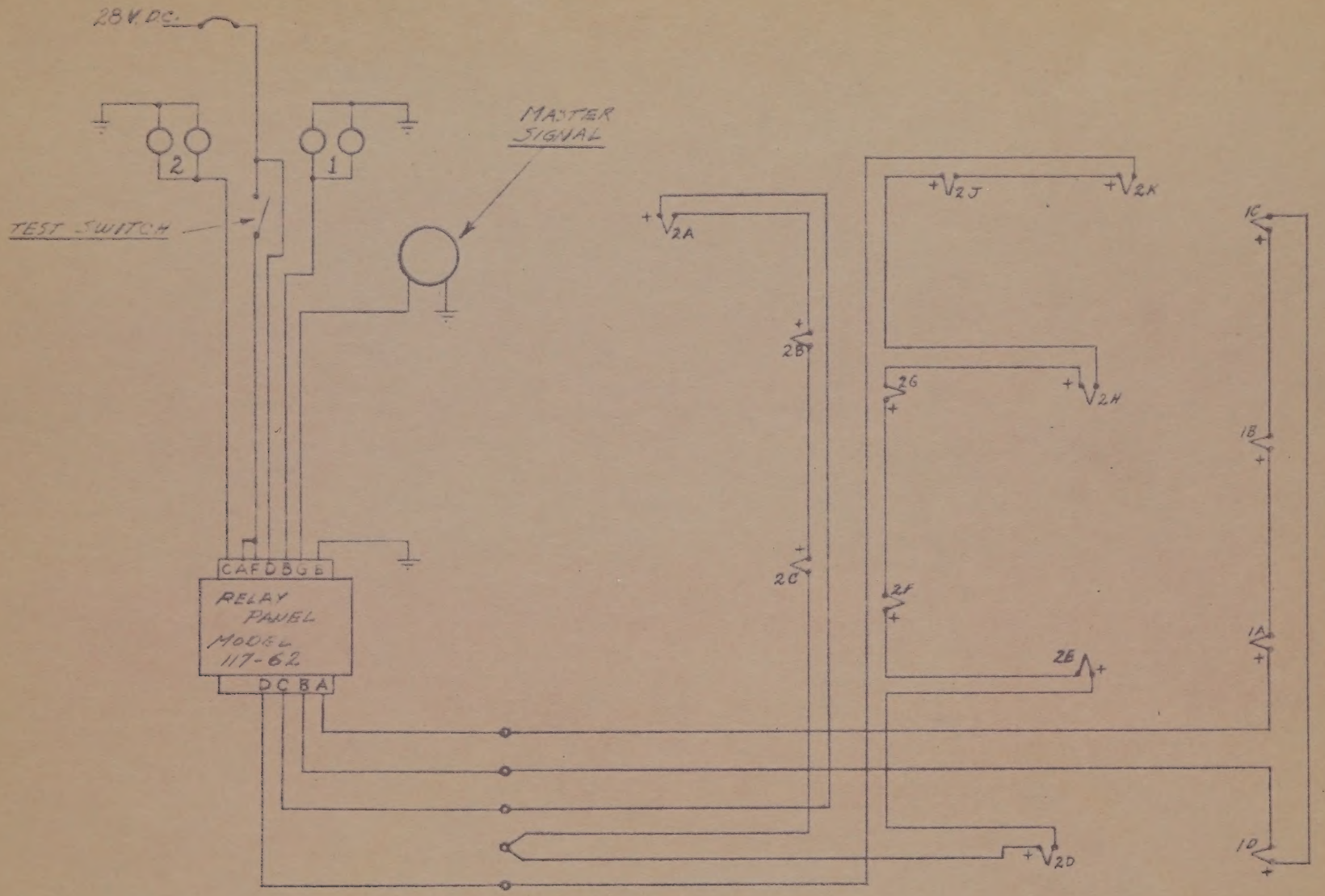


Schematic Wiring Diagram - Eight Circuit Panels - continued



Schematic Wiring Diagram - Eight Circuit Panels - continued





FIRE DETECTION MOCK-UP
— WIRING DIAGRAM —

9/26/49